NI SignalExpress™

Getting Started with NI SignalExpress

Tektronix® Edition

June 2006
374297B-01

NATIONAL INSTRUMENTS™

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

Worldwide Offices

Australia 1800 300 800, Austria 43 0 662 45 79 90 0, Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599, Canada 800 433 3488, China 86 21 6555 7838, Czech Republic 420 224 235 774, Denmark 45 45 76 26 00, Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24, Germany 49 0 89 741 31 30, India 91 80 41190000, Israel 972 0 3 6393737, Italy 39 02 413091, Japan 81 3 5472 2970, Korea 82 02 3451 3400, Lebanon 961 0 1 33 28 28, Malaysia 1800 887710, Mexico 01 800 010 0793, Netherlands 31 0 348 433 466, New Zealand 0800 553 322, Norway 47 0 66 90 76 60, Poland 48 22 3390150, Portugal 351 210 311 210, Russia 7 095 783 68 51, Singapore 1800 226 5886, Slovenia 386 3 425 4200, South Africa 27 0 11 805 8197, Spain 34 91 640 0085, Sweden 46 0 8 587 895 00, Switzerland 41 56 200 51 51, Taiwan 886 02 2377 2222, Thailand 662 278 6777, United Kingdom 44 0 1635 523545

For further support information, refer to the *Technical Support and Professional Services* appendix. To comment on National Instruments documentation, refer to the National Instruments Web site at ni.com/info and enter the info code feedback.

© 2005–2006 National Instruments Corporation. All rights reserved.

Important Information

Warranty

The media on which you receive National Instruments software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace software media that do not execute programming instructions if National Instruments receives notice of such defects during the warranty period. National Instruments does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

National Instruments believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, National Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult National Instruments if errors are suspected. In no event shall National Instruments be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, NATIONAL INSTRUMENTS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF NATIONAL INSTRUMENTS SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. NATIONAL INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. This limitation of the liability of National Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. Any action against National Instruments must be brought within one year after the cause of action accrues. National Instruments shall not be liable for any delay in performance due to causes beyond its reasonable control. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow the National Instruments installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failure or surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

Copyright

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of National Instruments Corporation.

National Instruments respects the intellectual property of others, and we ask our users to do the same. NI software is protected by copyright and other intellectual property laws. Where NI software may be used to reproduce software or other materials belonging to others, you may use NI software only to reproduce materials that you may reproduce in accordance with the terms of any applicable license or other legal restriction.

Trademarks

National Instruments, NI, ni.com, and LabVIEW are trademarks of National Instruments Corporation. Refer to the *Terms of Use* section on `ni.com/legal` for more information about National Instruments trademarks.

Tektronix® and Tek are registered trademarks of Tektronix, Inc. Other product and company names mentioned herein are trademarks or trade names of their respective companies.

Members of the National Instruments Alliance Partner Program are business entities independent from National Instruments and have no agency, partnership, or joint-venture relationship with National Instruments.

Patents

For patents covering National Instruments products, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your CD, or `ni.com/patents`.

WARNING REGARDING USE OF NATIONAL INSTRUMENTS PRODUCTS

(1) NATIONAL INSTRUMENTS PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN.

(2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO DEVELOP AN APPLICATION, INSTALLATION ERRORS, SOFTWARE AND HARDWARE COMPATIBILITY PROBLEMS, MALFUNCTIONS OR FAILURES OF ELECTRONIC MONITORING OR CONTROL DEVICES, TRANSIENT FAILURES OF ELECTRONIC SYSTEMS (HARDWARE AND/OR SOFTWARE), UNANTICIPATED USES OR MISUSES, OR ERRORS ON THE PART OF THE USER OR APPLICATIONS DESIGNER (ADVERSE FACTORS SUCH AS THESE ARE HEREAFTER COLLECTIVELY TERMED "SYSTEM FAILURES"). ANY APPLICATION WHERE A SYSTEM FAILURE WOULD CREATE A RISK OF HARM TO PROPERTY OR PERSONS (INCLUDING THE RISK OF BODILY INJURY AND DEATH) SHOULD NOT BE RELIANT SOLELY UPON ONE FORM OF ELECTRONIC SYSTEM DUE TO THE RISK OF SYSTEM FAILURE. TO AVOID DAMAGE, INJURY, OR DEATH, THE USER OR APPLICATION DESIGNER MUST TAKE REASONABLY PRUDENT STEPS TO PROTECT AGAINST SYSTEM FAILURES, INCLUDING BUT NOT LIMITED TO BACK-UP OR SHUT DOWN MECHANISMS. BECAUSE EACH END-USER SYSTEM IS CUSTOMIZED AND DIFFERS FROM NATIONAL INSTRUMENTS' TESTING PLATFORMS AND BECAUSE A USER OR APPLICATION DESIGNER MAY USE NATIONAL INSTRUMENTS PRODUCTS IN COMBINATION WITH OTHER PRODUCTS IN A MANNER NOT EVALUATED OR CONTEMPLATED BY NATIONAL INSTRUMENTS, THE USER OR APPLICATION DESIGNER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY OF NATIONAL INSTRUMENTS PRODUCTS WHENEVER NATIONAL INSTRUMENTS PRODUCTS ARE INCORPORATED IN A SYSTEM OR APPLICATION, INCLUDING, WITHOUT LIMITATION, THE APPROPRIATE DESIGN, PROCESS AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION.

Conventions

The following conventions are used in this manual:

<>	Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, AO <3..0>.
[ ]	Square brackets enclose optional items—for example, [`response`].
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Contents

Chapter 1
Introduction to NI SignalExpress Tektronix Edition

NI SignalExpress Tektronix Edition for the Design Lab 1-1
Extending NI SignalExpress Tektronix Edition Projects with LabVIEW 1-2

Chapter 2
Getting Started with NI SignalExpress Tektronix Edition

Installing NI SignalExpress Tektronix Edition 2-1
- Minimum System Requirements 2-1
- Installation Instructions 2-1

NI SignalExpress Tektronix Edition Version Availability 2-2
NI SignalExpress Tektronix Edition Licensing Options 2-4
- NI SignalExpress Tektronix Edition Base License 2-4
- NI Signal Express Tektronix Edition Professional License 2-4

Chapter 3
Connecting and Controlling Instruments

Tektronix DPO4000 Series Oscilloscopes 3-1
- Connecting over USB 3-1
- Connecting over Ethernet 3-4

Tektronix TDS3000 Series Oscilloscopes 3-6
- Connecting over Ethernet 3-6
- Connecting over GPIB 3-8

Tektronix TDS2000B and TDS1000B Series Oscilloscopes 3-10
- Connecting over USB 3-10

Tektronix AFG3000 Series Arbitrary/Function Generators 3-12
- Connecting over USB 3-12
- Connecting over Ethernet 3-14
- Connecting over GPIB 3-16

Chapter 4
Working with Projects

Loading a Project 4-1
Running a Project and Displaying Signals 4-2
Configuring a Step 4-4
Moving and Deleting Steps 4-8
Handling Errors and Warnings 4-8

Chapter 5
Working with Signals

Graphing Signals 5-1
Importing a Signal from a File 5-3
Aligning and Comparing Signals 5-4
Signal Types in NI SignalExpress Tektronix Edition 5-6
Exporting and Printing Signals 5-7
Exporting Signals to Microsoft Excel 5-7
Printing Signals 5-7
Saving Signals as Images 5-7
Saving Tektronix Scope Images 5-7
Logging Data to a File 5-7

Chapter 6
Performing Sweep Measurements

Defining Sweep Ranges and Outputs 6-1
Plotting Sweep Results 6-4
Running Multi-Dimensional Sweeps 6-6

Chapter 7
Extending NI SignalExpress Tektronix Edition Projects with LabVIEW

Importing LabVIEW VIs into NI SignalExpress Tektronix Edition as Steps 7-1

Chapter 8
Where to Go from Here

NI SignalExpress Tektronix Edition Sample Projects 8-1
Using Other Instruments with NI SignalExpress Tektronix Edition 8-1
Related Documentation 8-1
Web Resources 8-2

Appendix A
Technical Support and Professional Services

1

Introduction to NI SignalExpress Tektronix Edition

National Instruments provides innovative solutions for scientists and engineers to build automated measurement systems based on industry-standard computers and platforms. National Instruments develops robust, industry-leading programming environments for automating measurement systems, such as LabVIEW for graphical development, LabWindows™/CVI™ for ANSI C programming, and Measurement Studio for Microsoft Visual Studio programming. You can use these programming tools with National Instruments measurement hardware and interfaces to traditional instruments to build custom advanced virtual instrumentation systems.

NI SignalExpress Tektronix Edition optimizes virtual instrumentation for design and test engineers by offering instant interactive measurements that require no programming. You can use NI SignalExpress Tektronix Edition interactively to acquire, generate, analyze, compare, import, and save signals. You can compare design data with measurement data in one step. NI SignalExpress Tektronix Edition extends the ease of use and performance of virtual instrumentation to those who must acquire or analyze signals without programming applications. You also can extend the functionality of NI SignalExpress Tektronix Edition by importing a custom virtual instrument (VI) created in LabVIEW or by converting an NI SignalExpress Tektronix Edition project to a LabVIEW block diagram so you can continue development in the LabVIEW environment.

NI SignalExpress Tektronix Edition for the Design Lab

Tektronix and National Instruments have partnered to help increase your productivity with the industry's most seamless oscilloscope-to-computer connectivity solution. NI SignalExpress Tektronix Edition is fully interactive measurement acquisition, analysis, and documentation

software. NI SignalExpress Tektronix Edition also includes the industry's first USB plug-and-play automatic configuration and connectivity. Using NI SignalExpress Tektronix Edition, you can take advantage of the following:

- Ability to configure and connect Tektronix instruments with the industry's first, true USB plug-and-play connectivity solution.
- An intuitive drag-and-drop user interface that does not require any programming.
- Capability to capture, transfer, and save measurement settings, waveforms, and screen images.
- Quickly import your simulated results and compare them against actual measured results live on-screen.
- More than 200 measurement, processing, analysis, and reporting operations that perform in real time.

NI SignalExpress Tektronix Edition also comes with built-in support for the following:

- Tektronix DPO4000, TDS3000, TDS2000B, and TDS1000B series oscilloscopes
- Tektronix AFG3000 series arbitrary/function generator
- Over 300 other common standalone instruments

Extending NI SignalExpress Tektronix Edition Projects with LabVIEW

You can extend the functionality of NI SignalExpress Tektronix Edition with LabVIEW when you build VIs with LabVIEW and import them into NI SignalExpress Tektronix Edition to expand the built-in measurement options.

Refer to Chapter 7, *Extending NI SignalExpress Tektronix Edition Projects with LabVIEW*, for more information about importing LabVIEW VIs as steps.

2

Getting Started with NI SignalExpress Tektronix Edition

This chapter provides information about NI SignalExpress Tektronix Edition system requirements, installation instructions, version availability, and available licensing options.

Installing NI SignalExpress Tektronix Edition

Before you begin the exercises in this manual, you must install NI SignalExpress Tektronix Edition on your computer. The NI SignalExpress Tektronix Edition setup program installs the software in 10 minutes.

Minimum System Requirements

To run NI SignalExpress Tektronix Edition, National Instruments recommends that your system meet the following requirements:

- 256 MB of memory (128 MB minimum)
- Pentium 4 processor or equivalent (Pentium III or Celeron 600 MHz minimum)

Installation Instructions

Complete the following steps to install NI SignalExpress Tektronix Edition on Windows 2000/XP.

1. National Instruments strongly recommends that you exit all programs before you run the NI SignalExpress Tektronix Edition installer. Applications that run in the background, such as virus scanning utilities, might cause the installer to take longer than average to complete.
2. Log on as an administrator or as a user with administrator privileges.
3. Insert the NI SignalExpress Tektronix Edition CD and follow the instructions that appear on the screen.

Note Unless you specify another location during installation, the NI SignalExpress Tektronix Edition installation program copies files to `<Program Files>\National Instruments\SignalExpressTekEd` directory.

4. After installation, check the hard disk for viruses and enable any virus detection programs you disabled.

The example projects you use with this manual are located in `<Program Files>\National Instruments\SignalExpressTekEd\Examples\Tutorial`. The solutions for each exercise are located in `<Program Files>\National Instruments\SignalExpressTekEd\Examples\Tutorial\Solutions`.

NI SignalExpress Tektronix Edition Version Availability

NI SignalExpress Tektronix Edition is available in both a professional and base version. Refer to the following table for a list of features available in each version.

Note Features that are not available in the NI SignalExpress Tektronix Edition base version will work for 30 days from the first use of the software. After 30 days, if you use any of these features, NI SignalExpress Tektronix Edition will only run for 10 minutes and you cannot save projects. If you use only Tektronix-specific steps in a project, the software functions as normal.

Table 2-1. Differences in NI SignalExpress Tektronix Edition Professional and Base Versions

	Professional	Base
Instrument Support		
DPO4000 Digital Phosphor Oscilloscopes	✓	✓
TDS3000 Digital Phosphor Oscilloscopes	✓	✓
TDS2000B Digital Storage Oscilloscopes	✓	✓
TDS1000B Digital Storage Oscilloscopes	✓	✓
AFG3000 Arbitrary/Function Generators	✓	✓

Table 2-1. Differences in NI SignalExpress Tektronix Edition Professional and Base Versions (Continued)

	Professional	Base
Over 300 common standalone instruments	✓	—
Visualization and Documentation		
Customizable graphing	✓	✓
Interactive cursors	✓	✓
Save signals to file	✓	✓
Print and export graphs	✓	✓
Drag and drop data into Microsoft Excel, Word, and WordPad	✓	✓
Automated data collection	✓	—
Signal Processing		
Software filters	✓	—
Scalar and waveform math	✓	—
Analog and digital conversion	✓	—
Interactive signal comparisons	✓	—
Load simulation data from PSPICE, Multisim, and other SPICE packages	✓	—
Time and Frequency Measurements		
Amplitude and level	✓	—
Timing and transition	✓	—
Power spectrum	✓	—
Frequency response	✓	—
Distortion measurements	✓	—
Tone extraction	✓	—

Table 2-1. Differences in NI SignalExpress Tektronix Edition Professional and Base Versions (Continued)

	Professional	Base
Measurement Automation		
Parameter sweeping	✓	—
Limit testing	✓	—

NI SignalExpress Tektronix Edition Licensing Options

This section is designed to assist you in understanding the licensing policies for NI Signal Express Tektronix Edition. This document does not replace the National Instruments Software License Agreement and should only be used as a reference.

NI SignalExpress Tektronix Edition Base License

The unlicensed version of NI SignalExpress Tektronix Edition gives you access to all features in Table 2-1 for 30 days. After that period, NI SignalExpress Tektronix Edition runs in unlicensed mode. If you do not activate a valid license within 30 days and you create a project that contains licensed steps, the following occurs:

Note Tektronix-specific steps are not licensed steps.

- Each time you drop a step that is licensed or not Tektronix-specific, a dialog box prompts you to activate the software.
- You cannot save a project.
- Projects close after 10 minutes.

Refer to the National Instruments Web site at `ni.com/tek` to purchase NI SignalExpress Tektronix Edition professional version.

NI Signal Express Tektronix Edition Professional License

The professional license provides you with the full functionality of NI SignalExpress Tektronix Edition, as shown in Table 2-1. You can activate NI SignalExpress Tektronix Edition professional version using the National Instruments License Manager or the NI SignalExpress Tektronix Edition installer.

3

Connecting and Controlling Instruments

NI SignalExpress Tektronix Edition provides native support for the Tektronix DPO4000, TDS3000, TDS2000B, and TDS1000B series oscilloscopes and AFG3000 series signal generators. This chapter covers the process of connecting instruments to the PC and performing signal generation and acquisition from within NI SignalExpress Tektronix Edition.

NI SignalExpress Tektronix Edition also supports over 300 of the most common standalone instruments, including the majority of instruments in the Tektronix oscilloscope and signal generator product lines. Refer to *Using Other Instruments with NI SignalExpress Tektronix Edition* in Chapter 8, *Where to Go from Here*, for more information about controlling other instruments.

Tektronix DPO4000 Series Oscilloscopes

Connecting over USB

With built-in USB plug-and-play capabilities in Windows XP, NI SignalExpress Tektronix Edition automatically detects when a Tektronix DPO4000 series oscilloscope connects to the PC and allows you to immediately control the oscilloscope and acquire signals from the oscilloscope. Complete the following steps to connect the Tektronix DPO4000 series oscilloscope:

1. Turn on the Tektronix DPO4000 series oscilloscope.

2. Using a USB device cable, plug the Type B, device-side connector into the USB device port on the back of the Tektronix DPO4000 series oscilloscope, as shown in Figure 3-1. Connect the Type A, host-side connector to your computer.

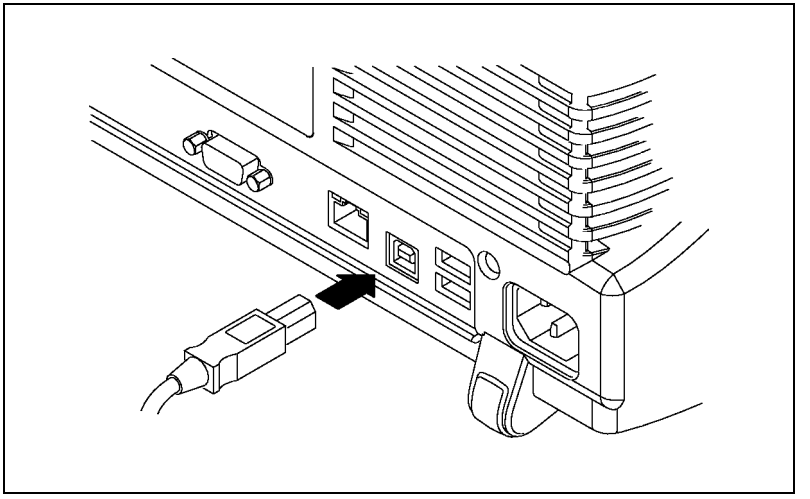


Figure 3-1. DPO4000 USB Connection

After completing the connections, Windows detects that you have connected a new device to the computer and prompts you to install the driver for the Tektronix DPO4000 series oscilloscope.

3. Click the **Next** button on the following dialog boxes to finish the installation of the Tektronix DPO4000 series oscilloscope driver.

Note You only need to perform Step 3 the first time you plug the Tektronix DPO4000 series oscilloscope into the computer. Subsequent connections immediately launch the dialog box discussed in Step 4.

4. Windows prompts you with a dialog box, as shown in Figure 3-2, indicating that the Tektronix DPO4000 series oscilloscope has been detected and prompts for the action to take. If **Control Instrument using NI SignalExpress - Tektronix Edition** is not selected, click **Control Instrument using NI SignalExpress - Tektronix Edition** and then click the **OK** button.

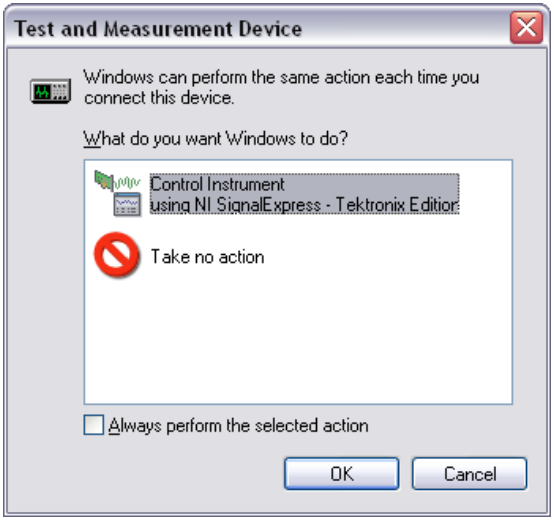

Test and Measurement Device
Windows can perform the same action each time you connect this device.
What do you want Windows to do?
Control Instrument using NI SignalExpress - Tektronix Edition
Take no action
Always perform the selected action
OK
Cancel

Figure 3-2. USB Plug-and-Play Dialog Box

5. NI SignalExpress Tektronix Edition launches and provides a live view of the Tektronix DPO4000 series oscilloscope, as shown in Figure 3-3.

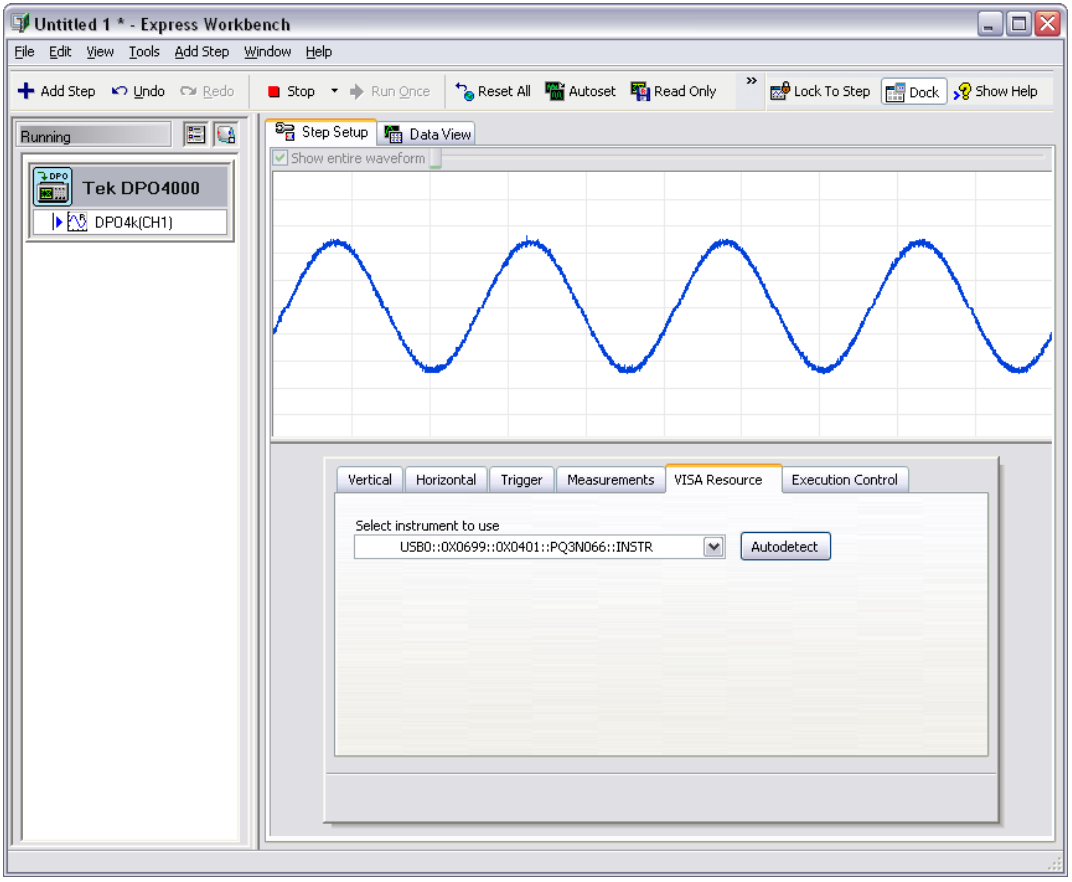

Untitled 1 * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Stop Run Once Reset All Autoset Read Only Lock To Step Dock Show Help
Running
Tek DPO4000
DPO4k(CH1)
Step Setup Data View
Show entire waveform
Vertical Horizontal Trigger Measurements VISA Resource Execution Control
Select instrument to use
USB0::0X0699::0X0401::PQ3N066::INSTR
Autodetect

Figure 3-3. Live Acquisition from Tektronix DPO4000 Series Oscilloscope

Connecting over Ethernet

Before you begin this section, refer to the *DPO4000 Series Digital Phosphor Oscilloscopes User Manual* to properly connect and configure your Tektronix DPO4000 series oscilloscope for communication over Ethernet. After you connect and configure the oscilloscope, complete the following steps to access the Tektronix DPO4000 series oscilloscope from within NI SignalExpress Tektronix Edition:

1. Launch NI SignalExpress Tektronix Edition by selecting **Start»All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition**.

2. Click the **Add Step** button, shown at left, and select **Tektronix»Acquire Signals»Tek DPO4000**. The Tektronix DPO4000 series oscilloscope **Step Setup** dialog box launches, as shown in Figure 3-4.

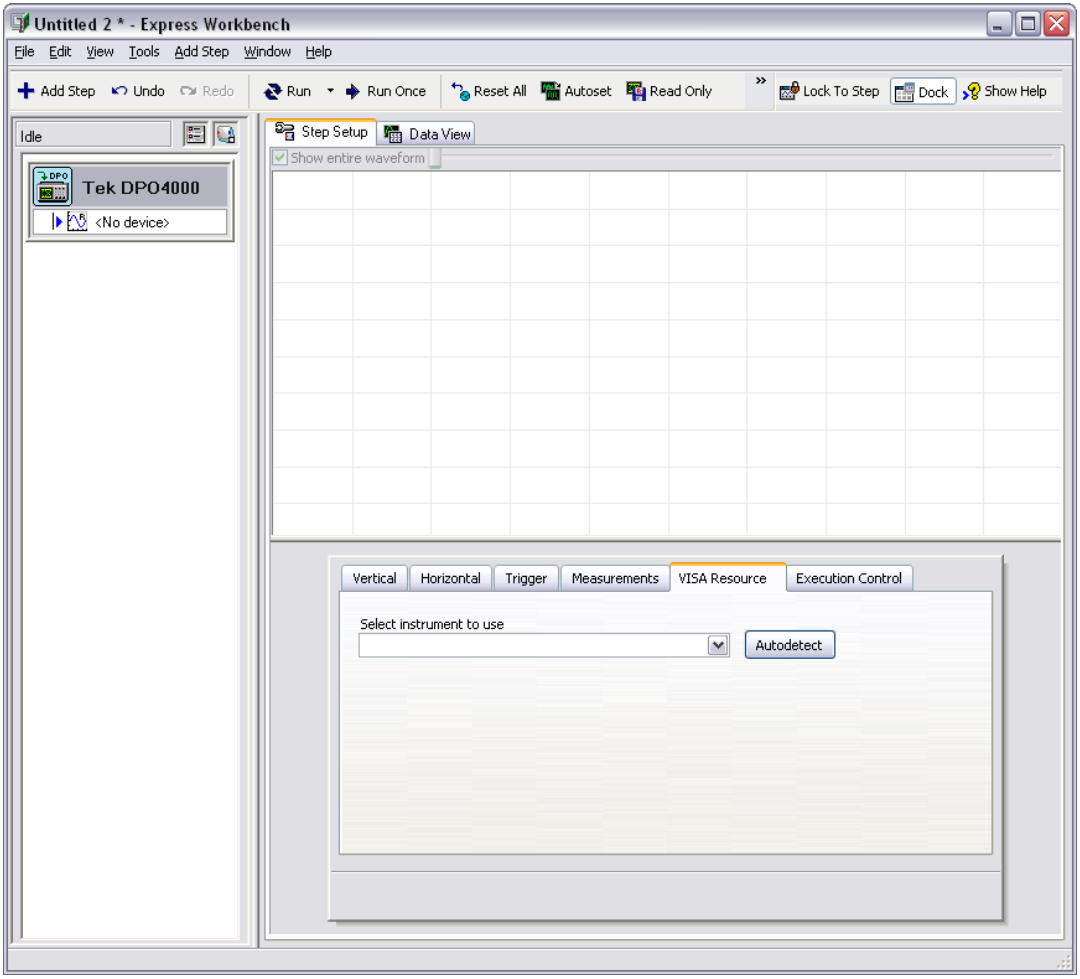

Untitled 2 * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Run Run Once Reset All Autoset Read Only Lock To Step Dock Show Help
Idle
Tek DPO4000
<No device>
Step Setup Data View
Show entire waveform
Vertical Horizontal Trigger Measurements VISA Resource Execution Control
Select instrument to use
Autodetect

Figure 3-4. Autodetect Tektronix DPO4000 Series Oscilloscope Connected Ethernet Connection

3. If you know the IP address of the connected Tektronix DPO4000 series oscilloscope, enter it in the **Select instrument to use** drop-down box on the **VISA Resource** tab.

   If you do not know the IP address, click the **Autodetect** button on the **VISA Resource** tab to scan the local subnet for a connected

Tektronix DPO4000 series oscilloscope. If a Tektronix DPO4000 series oscilloscope is found, NI SignalExpress Tektronix Edition displays the instrument address, connects to the Tektronix DPO4000 series oscilloscope, and performs one waveform acquisition.

Note You must manually enter the instrument address when connecting to a Tektronix DPO4000 series oscilloscope that is not on the local subnet. Refer to the *NI Express Workbench Help* for information about how to manually connect to a Tektronix DPO4000 series oscilloscope by selecting **Help»Express Workbench Help**, clicking the **Search** tab, and entering `"Tek DPO4000"`.

4. Click the **Run** button, shown at left, to continually acquire a signal from the Tektronix DPO4000 series oscilloscope.

Tektronix TDS3000 Series Oscilloscopes

Connecting over Ethernet

Before you begin this section, refer to the *TDS3000 Series User Manual* to properly connect and configure your Tektronix TDS3000 series oscilloscope for communication over Ethernet. After you connect and configure the oscilloscope, complete the following steps to access the Tektronix TDS3000 series oscilloscope from within NI SignalExpress Tektronix Edition:

1. Launch NI SignalExpress Tektronix Edition by selecting **Start» All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition**.

2. Click the **Add Step** button, shown at left, and select **Tektronix» Acquire Signals»Tek TDS3000**. The Tektronix TDS3000 series oscilloscope **Step Setup** dialog box launches, as shown in Figure 3-5.

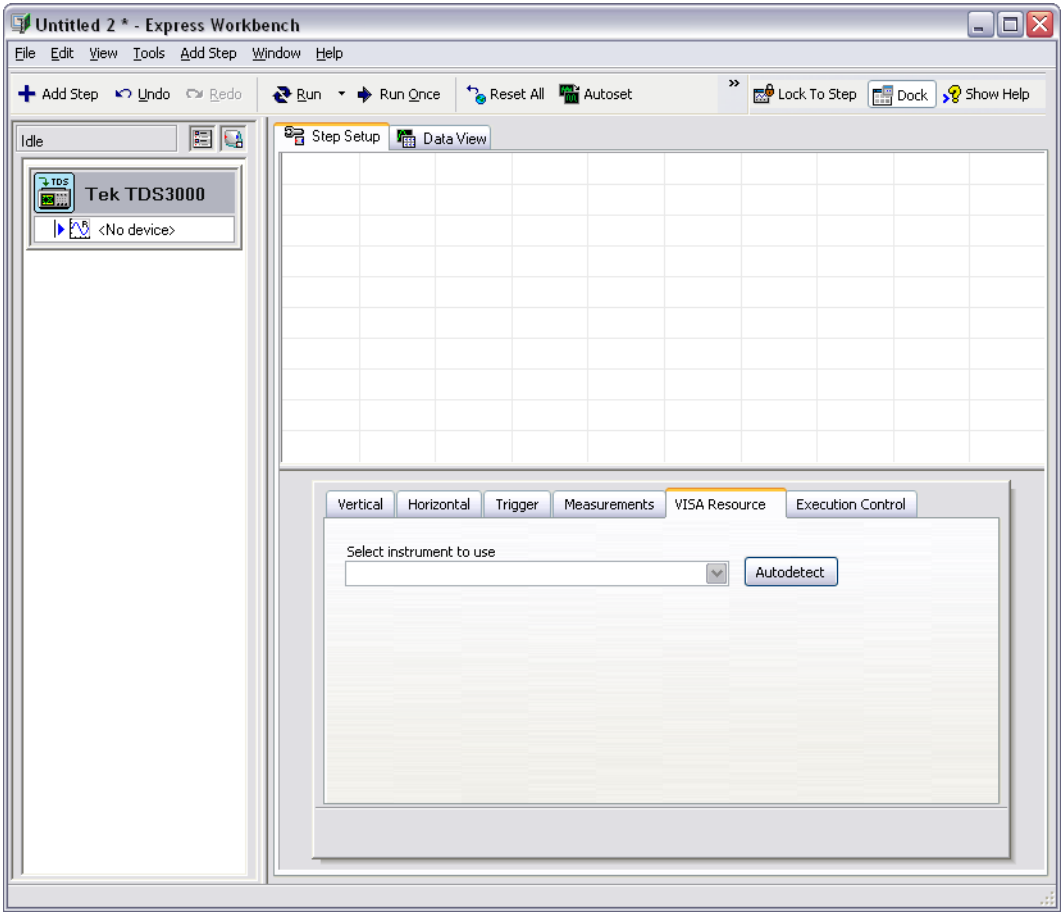

Untitled 2 * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Run Run Once Reset All Autoset Lock To Step Dock Show Help
Idle
Tek TDS3000
<No device>
Step Setup Data View
Vertical Horizontal Trigger Measurements VISA Resource Execution Control
Select instrument to use
Autodetect

Figure 3-5. Autodetect Tektronix TDS3000 Series Oscilloscopes Ethernet Connection

3. If you know the IP address of the connected Tektronix TDS3000 series oscilloscope, enter it in the **Select instrument to use** drop-down box on the **VISA Resource** tab.

   If you do not know the IP address, click the **Autodetect** button to scan the local subnet for connected Tektronix TDS3000 series oscilloscopes. If NI SignalExpress Tektronix Edition detects a Tektronix TDS3000 series oscilloscope on the local subnet, NI SignalExpress Tektronix Edition displays the instrument address, connects to the Tektronix TDS3000 series oscilloscope, and performs one waveform acquisition.

Note You must manually enter the instrument address when connecting to a Tektronix TDS3000 series oscilloscope that is not on the local subnet. Refer to the *NI Express Workbench Help* for information on how to manually connect to a Tektronix TDS3000 series oscilloscope by selecting **Help»Express Workbench Help**, clicking the **Search** tab, and entering `"Tek TDS3000"`.

4. Click the **Run** button, shown at left, to continually acquire from the Tektronix TDS3000 series oscilloscope.

Connecting over GPIB

Complete the following steps to connect and control the Tektronix TDS3000 series oscilloscope over GPIB:

1. Connect the Tektronix TDS3000 series oscilloscope to your computer using a GPIB cable.
2. Launch NI SignalExpress Tektronix Edition by selecting **Start» All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition**.

3. Click the **Add Step** button, shown at left, and select **Tektronix» Acquire Signals»Tek TDS3000**. The Tektronix TDS3000 series oscilloscope **Step Setup** dialog box launches, as shown in Figure 3-6.

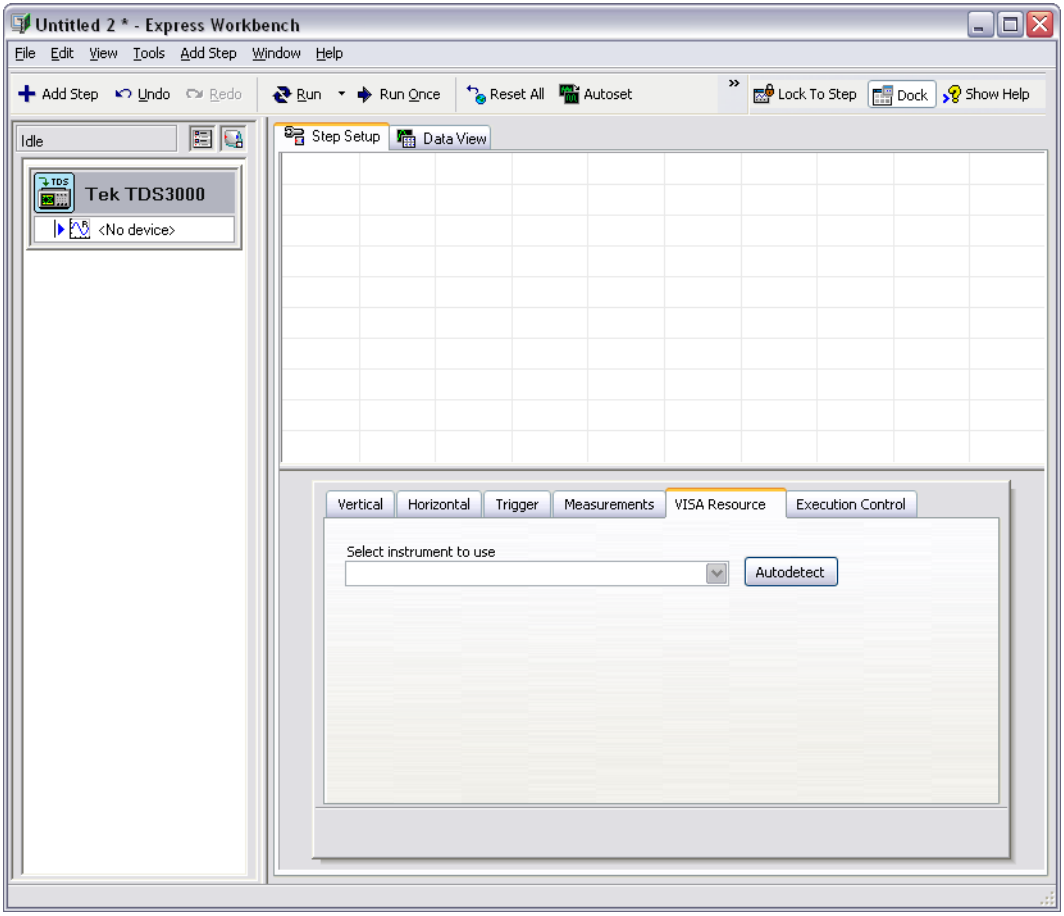

Untitled 2 * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Run Run Once Reset All Autoset Lock To Step Dock Show Help
Idle
Tek TDS3000
<No device>
Step Setup Data View
Vertical Horizontal Trigger Measurements VISA Resource Execution Control
Select instrument to use
Autodetect

Figure 3-6. Autodetect Tektronix TDS3000 Series Oscilloscopes GPIB Connection

4. Click the **Autodetect** button on the **VISA Resource** tab to find and connect to the Tektronix TDS3000 series oscilloscope.

5. Click the **Run** button, shown at left, to start signal acquisition with the Tektronix TDS3000 series oscilloscope.

Tektronix TDS2000B and TDS1000B Series Oscilloscopes

Connecting over USB

With built-in USB plug-and-play capabilities in Windows XP, NI SignalExpress Tektronix Edition automatically detects when a Tektronix TDS2000B or TDS1000B series oscilloscope connects to the PC and allows you to immediately control the oscilloscope and acquire signals from the oscilloscope. Complete the following steps to connect the Tektronix TDS2000B or TDS1000B series oscilloscope:

1. Turn on the Tektronix TDS2000B or TDS1000B series oscilloscope.
2. Using a USB device cable, plug the Type B, device-side connector into the USB device port on the back of the Tektronix TDS2000B/1000B, as shown in Figure 3-7. Connect the Type A, host-side connector to your computer.

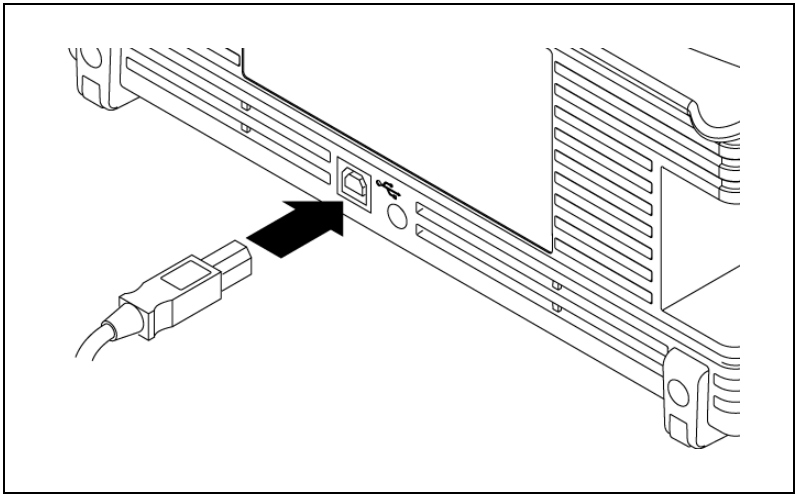


Figure 3-7. TDS2000B/1000B USB Connection

After completing the connections, Windows detects that you have connected a new device to the computer and prompts you to install the driver for the Tektronix TDS2000B or TDS1000B series oscilloscope.

3. Click the **Next** button on the following dialog boxes to finish the installation of the Tektronix TDS2000B or TDS1000B series oscilloscope driver.

Note You only need to perform Step 3 the first time you plug the Tektronix TDS2000B or TDS1000B series oscilloscope into the computer. Subsequent connections immediately launch the dialog box discussed in Step 4.

4. Windows prompts you with a dialog box, as shown in Figure 3-8, indicating that the Tektronix TDS2000B or TDS1000B series oscilloscope has been detected and prompts for the action to take. If **Control Instrument using NI SignalExpress - Tektronix Edition** is not selected, click **Control Instrument using NI SignalExpress - Tektronix Edition** and then click the **OK** button.

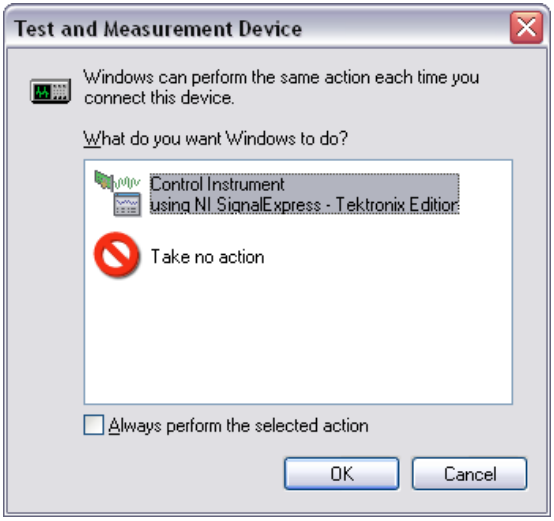

Test and Measurement Device
Windows can perform the same action each time you connect this device.
What do you want Windows to do?
Control Instrument using NI SignalExpress - Tektronix Edition
Take no action
Always perform the selected action
OK
Cancel

Figure 3-8. USB Plug-and-Play Dialog Box

5. NI SignalExpress Tektronix Edition launches and provides a live view of the Tektronix TDS2000B or TDS1000B series oscilloscope.

Tektronix AFG3000 Series Arbitrary/Function Generators

Connecting over USB

With built-in USB plug-and-play capabilities, NI SignalExpress Tektronix Edition automatically detects when a Tektronix AFG3000 series arbitrary/function generator connects to the PC and allows you to immediately control and generate signals. Complete the following steps to connect the Tektronix AFG3000 series arbitrary/function generator over USB:

1. Turn on the Tektronix AFG3000 series arbitrary/function generator.
2. Using a USB device cable, plug the Type B, device-side connector into the USB device port on the back of the Tektronix AFG3000 series arbitrary/function generator. Connect the Type A, host-side connector to your computer.

   After you complete the connections, Windows detects that you have connected a new device to the computer and prompts you to install the driver for the AFG3000.
3. Click the **Next** button in the dialog boxes that follow to finish the installation of the Tektronix AFG3000 series arbitrary/function generator.

Note You only need to perform Step 3 the first time the you plug a Tektronix AFG3000 series arbitrary/function generator into the computer. Subsequent connections immediately launch the dialog box discussed in Step 4.

4. Windows prompts you with a dialog box, as shown in Figure 3-9, indicating that the Tektronix AFG3000 series arbitrary/function generator has been detected and prompts for the action to take. If **Control Instrument using NI SignalExpress - Tektronix Edition** is not selected, click **Control Instrument using NI SignalExpress - Tektronix Edition** and then click the **OK** button.

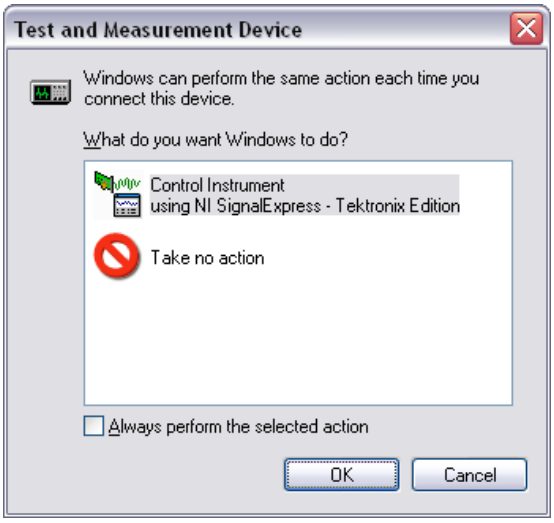

Test and Measurement Device
Windows can perform the same action each time you connect this device.
What do you want Windows to do?
Control Instrument using NI SignalExpress - Tektronix Edition
Take no action
Always perform the selected action
OK
Cancel

Figure 3-9. USB Plug-and-Play Dialog Box

5. NI SignalExpress Tektronix Edition launches and provides a live connection to the Tektronix AFG3000 series arbitrary/function generator, as shown in Figure 3-10.

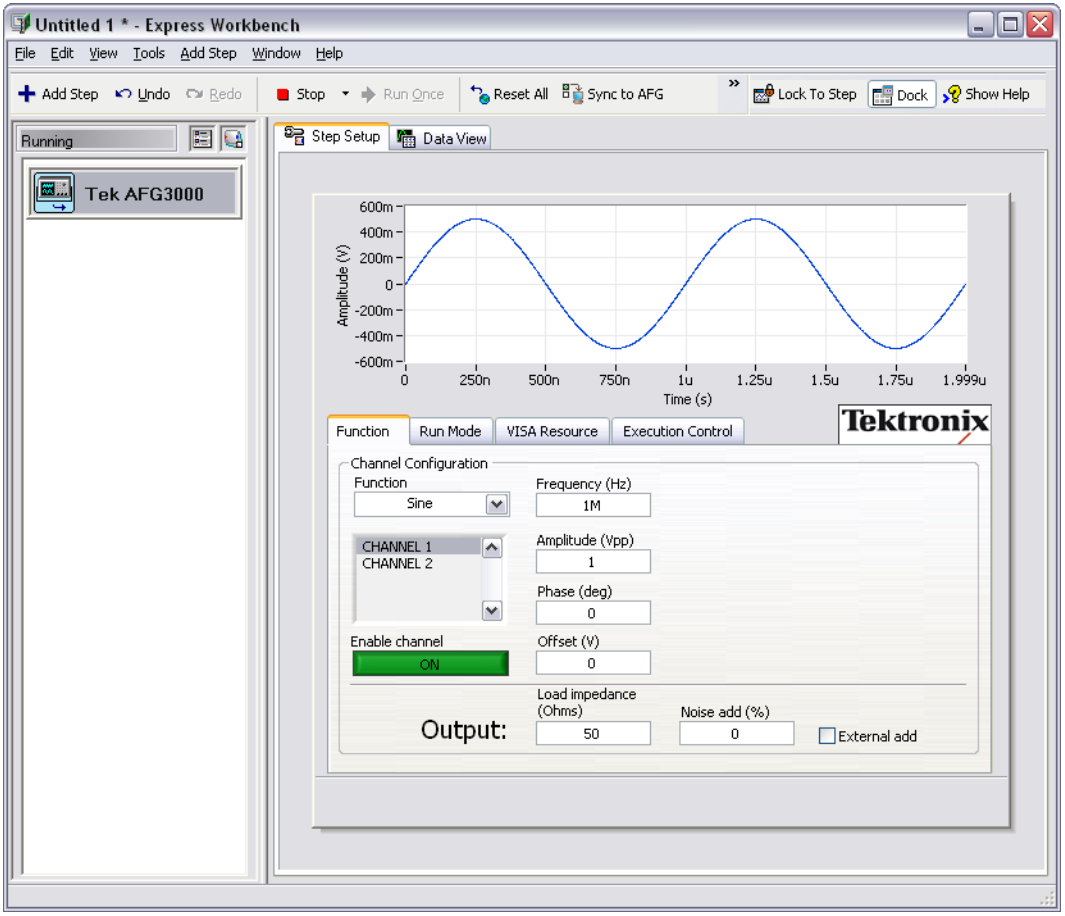


Figure 3-10. Live Acquisition from Tektronix AFG3000 Series Arbitrary/Function Generator

Connecting over Ethernet

Before you begin this section, refer to the *AFG3000 Series Quick Start User Manual* to properly connect and configure the Tektronix AFG3000 series arbitrary/function generator for communication over Ethernet. After you connect and configure the arbitrary/function generator, complete the following steps to access the Tektronix AFG3000 series arbitrary/function generator from within NI SignalExpress Tektronix Edition:

1. Launch NI SignalExpress Tektronix Edition by selecting **Start»All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition**.

2. Click the **Add Step** button, shown at left, and select **Tektronix» Generate Signals»Tek AFG3000**. The Tektronix AFG3000 series arbitrary/function generator **Step Setup** dialog box launches, as shown in Figure 3-11.

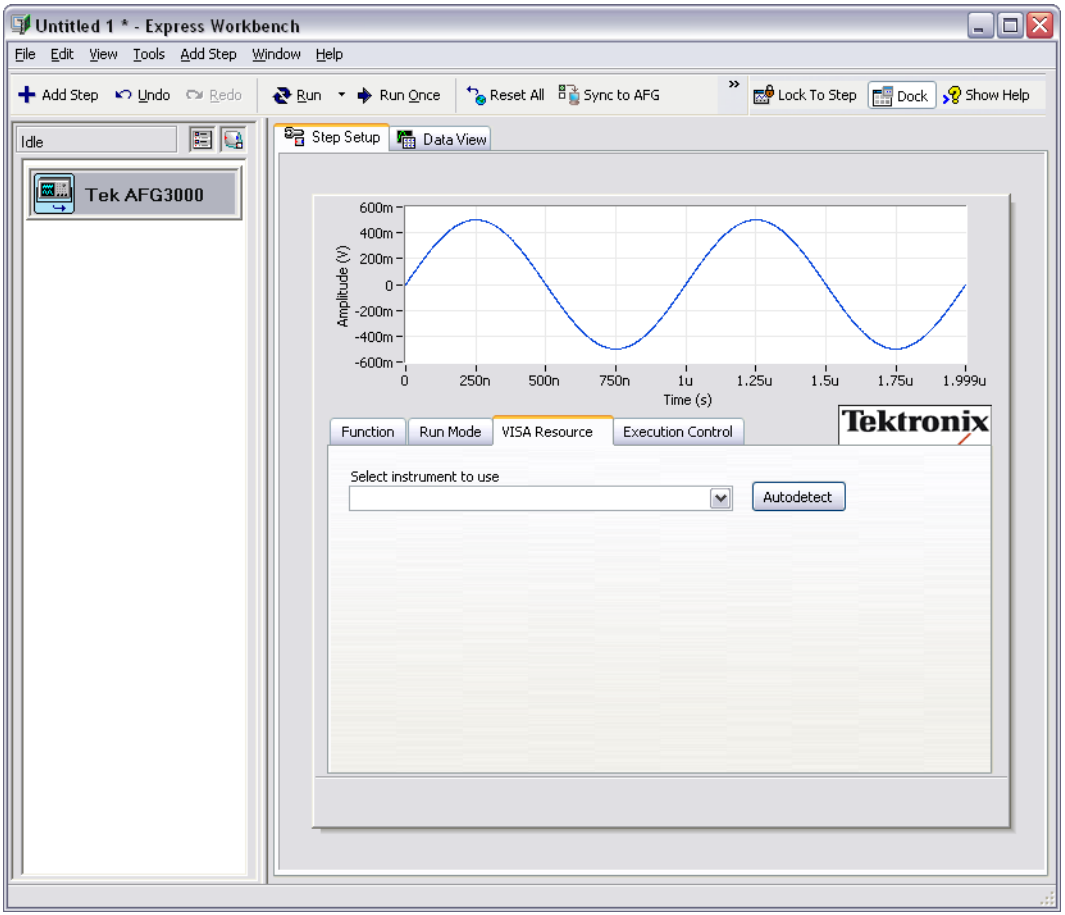

Untitled 1 * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Run Run Once Reset All Sync to AFG Lock To Step Dock Show Help
Idle
Tek AFG3000
Step Setup Data View
600m 400m 200m 0 -200m -400m -600m
Amplitude (V)
0 250n 500n 750n 1u 1.25u 1.5u 1.75u 1.999u
Time (s)
Function Run Mode VISA Resource Execution Control
Tektronix
Select instrument to use
Autodetect

Figure 3-11. Autodetect Tektronix AFG3000 Series Arbitrary/Function Generator Ethernet Connection

3. Click the **Autodetect** button on the **VISA Resource** tab to scan the local subnet for connected Tektronix AFG3000 series arbitrary/function generators. If NI SignalExpress Tektronix Edition detects a Tektronix AFG3000 series arbitrary/function generator on the local subnet, NI SignalExpress Tektronix Edition displays the instrument address and connects to the Tektronix AFG3000 series arbitrary/function generator.

Note You must manually enter the instrument address when you connect to a Tektronix AFG3000 series arbitrary/function generator that is not on the local subnet. Refer to the *NI Express Workbench Help* for information about how to manually connect to a Tektronix AFG3000 series arbitrary/function generator by selecting **Help»Express Workbench Help**, clicking the **Search** tab, and entering `"Tek AFG3000"`.

4. Click the **Run** button, shown at left, to start signal generation using the Tektronix AFG3000 series arbitrary/function generator.

Connecting over GPIB

Complete the following steps to connect and control the Tektronix AFG3000 series arbitrary/function generator over GPIB:

1. Connect the Tektronix AFG3000 series arbitrary/function generator to your computer using a GPIB cable.
2. Launch NI SignalExpress Tektronix Edition by selecting **Start» All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition.**

3. Click the **Add Step** button, shown at left, and select **Tektronix»Generate Signals»Tek AFG3000**. The Tektronix AFG3000 series arbitrary/function generator **Step Setup** dialog box launches, as shown in Figure 3-12.

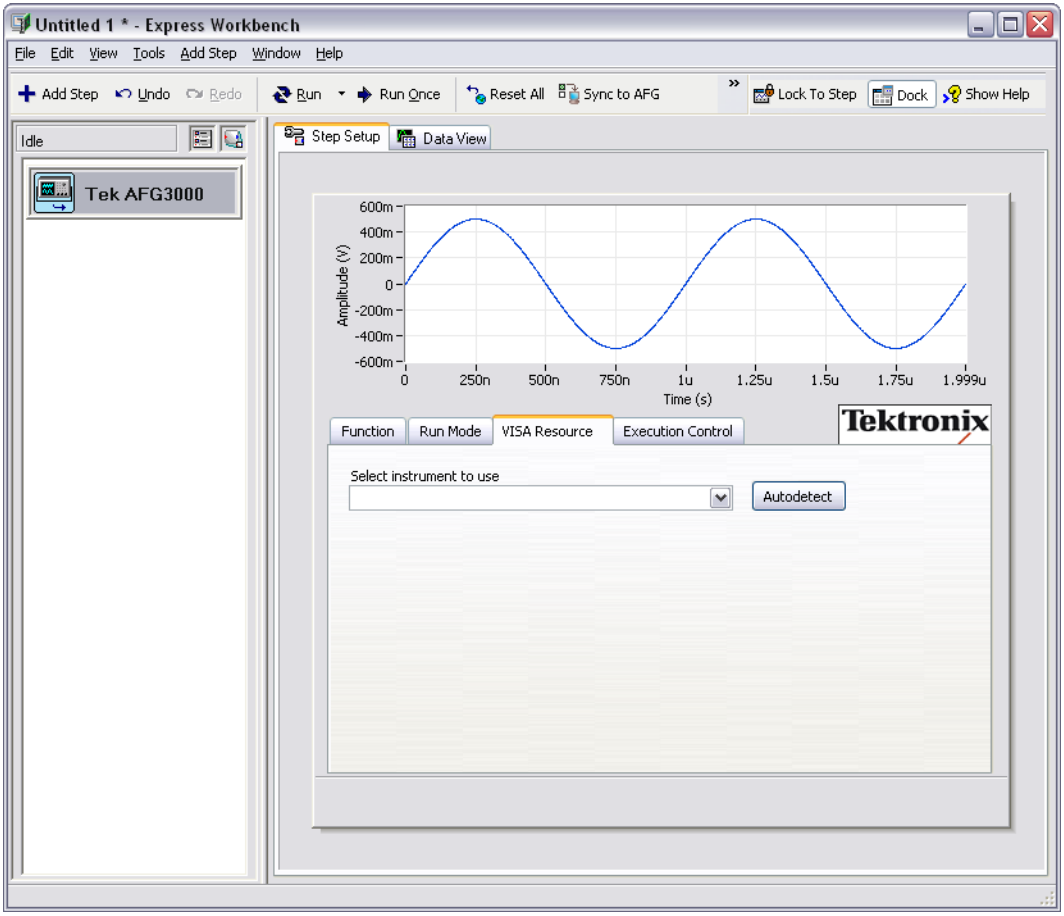


Figure 3-12. Autodetect Tektronix AFG3000 Series Arbitrary Function Generator GPIB Connection

4. Click the **Autodetect** button on the **VISA Resource** tab to find and connect to the Tektronix AFG3000 series arbitrary/function generator.

5. Click the **Run** button, shown at left, to start signal generation with the Tektronix AFG3000 series arbitrary/function generator.

4

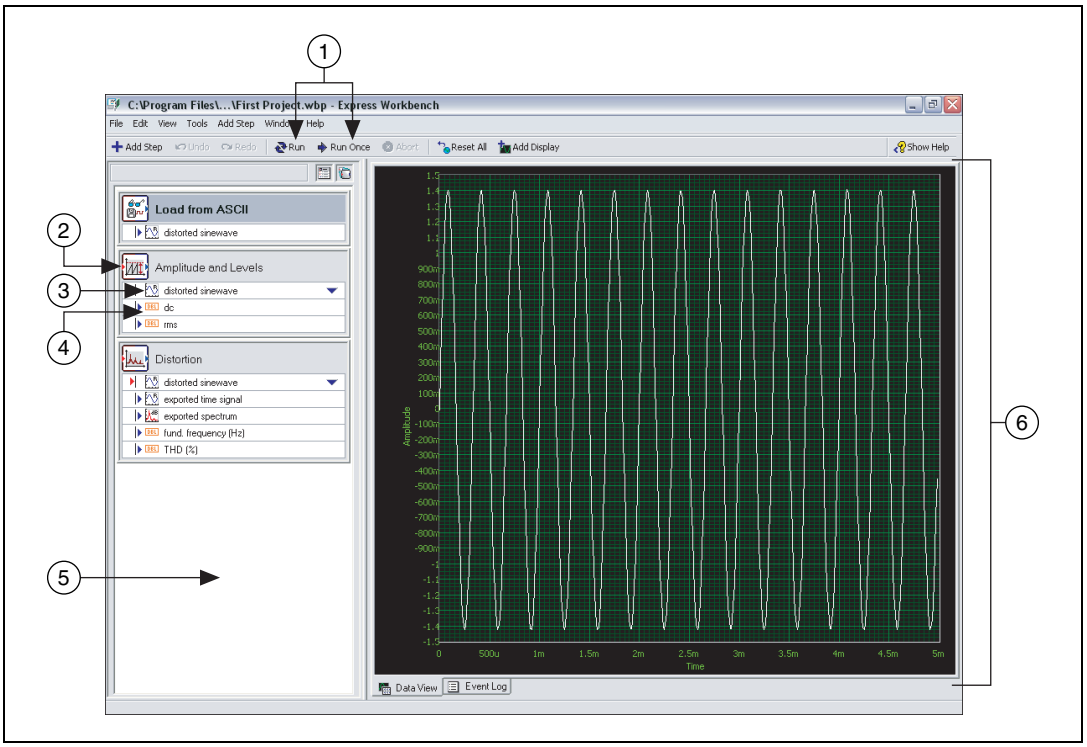
Working with Projects

You can use NI SignalExpress Tektronix Edition to define measurement procedures by adding and configuring steps in an interactive measurement environment. A step is a configurable function that acquires, generates, analyzes, loads, or stores signals. Steps process input signals and produce output signals. You can configure the operation of a step by specifying values in a **Step Setup** dialog box. A saved sequence of configured steps is an NI SignalExpress Tektronix Edition project. This chapter teaches you about the basic layout of NI SignalExpress Tektronix Edition. You learn how to load and run existing projects and how to configure steps in these projects.

Loading a Project

Complete the following steps to load a sample project in NI SignalExpress Tektronix Edition:

1. Launch NI SignalExpress Tektronix Edition by selecting **Start»All Programs»National Instruments»SignalExpress Tektronix Edition»SignalExpress Tektronix Edition**.
2. Select **File»Open Project**, navigate to the `<SignalExpressTekEd>\Examples\Tutorial` directory, and double-click `First Project.wbp`. Workbench projects refer to the Express Workbench framework in which NI SignalExpress Tektronix Edition resides.
3. Examine the dialog box that launches, as shown in Figure 4-1, to learn about the different components of NI SignalExpress Tektronix Edition.



1	Execution control buttons	3	Input	5	Project View
2	Step	4	Output	6	Data View

Figure 4-1. First Project.wbp

The left pane is the Project View, which presents the order of operations, or steps, for the project. The right pane is the Data View, which displays the signal that the project generates and analyzes.

Running a Project and Displaying Signals

NI SignalExpress Tektronix Edition uses the following two execution modes: Run and Run Once. When you click the Run button, NI SignalExpress Tektronix Edition executes all steps in a project continuously until you click the **Stop** button. The **Stop** button is visible in place of the **Run** button when a project runs. While steps in the project execute, the Data View updates continuously. While the project runs, you can change the measurement configurations and view the results immediately. If you modify the configuration of steps while a project runs,

NI SignalExpress Tektronix Edition gives you direct, immediate feedback on the changes you make. When you click the **Run Once** button, NI SignalExpress Tektronix Edition executes all steps in the project one time.

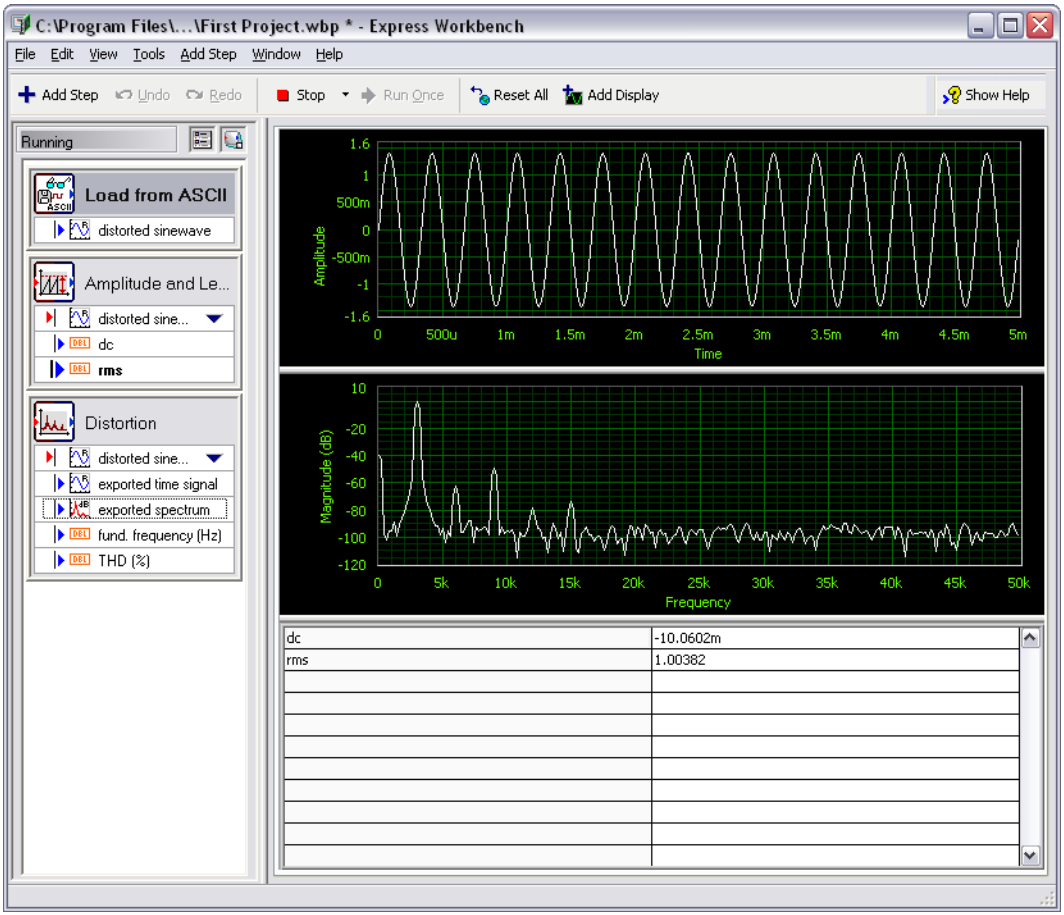


Figure 4-2. NI SignalExpress Tektronix Edition Project and Data Views

Configuring a Step

A step is a configurable function that acquires, generates, analyzes, loads, or stores signals. Steps process input signals and produce output signals. You can configure the operation of a step in NI SignalExpress Tektronix Edition by specifying values in the **Step Setup** dialog box for that step. While a project runs, you can modify the configuration of steps to view immediate feedback on the changes and adjust the measurements until you achieve the results you need.

Complete the following steps to configure the Distortion and Amplitude and Levels steps:

1. Double-click the **Distortion** step in the Project View. The **Step Setup** dialog box for the Distortion step appears, as shown in Figure 4-3. If the **Step Setup** dialog box is docked, click the **Dock** button, shown at left, on the toolbar to undock the **Step Setup** dialog box.

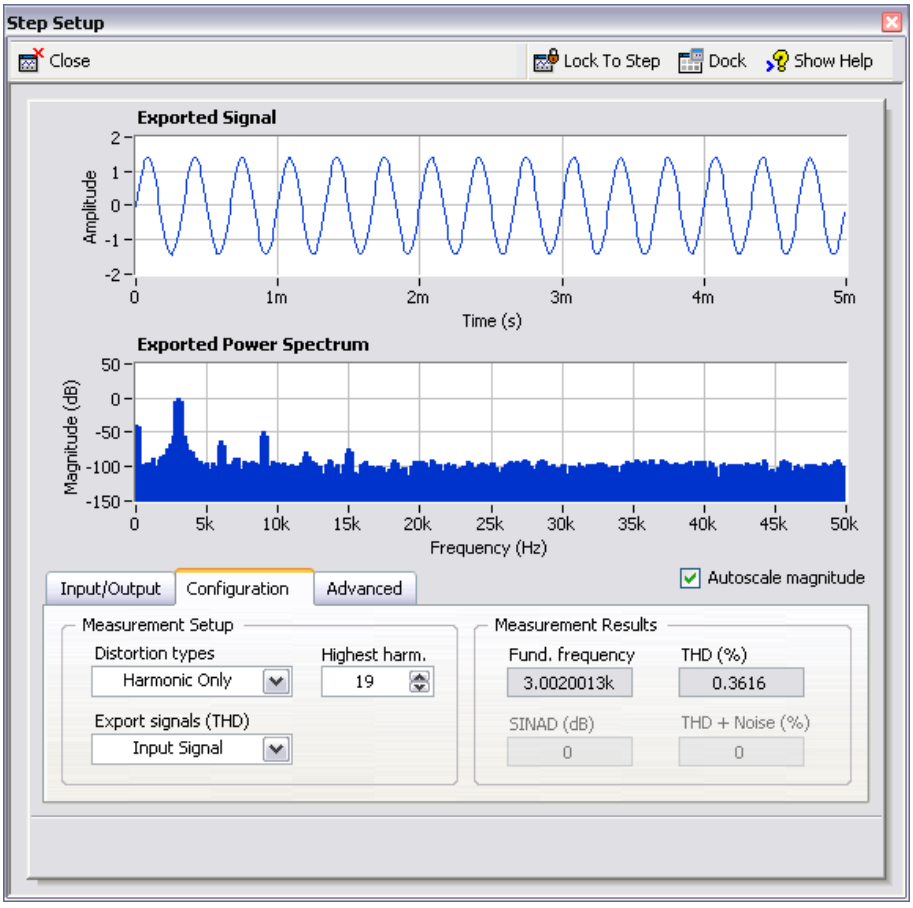


Figure 4-3. Distortion Step Setup Dialog Box

On the **Configuration** tab, the settings indicate that the Distortion step receives a time-domain waveform signal as an input, performs a power spectrum on the signal to convert it to the frequency domain, and computes the total harmonic distortion (THD) and fundamental frequency of the signal. The Distortion step generates the following three measurements as outputs: the spectrum, the THD, and the fundamental frequency of the original time-domain waveform input.

2. If the context help does not appear on the right side of the **Step Setup** dialog box, click the **Show Help** button, shown at left, to display complete reference information about the step.

The upper half of the context help displays information about the step, and the lower half of the context help displays information about an object when you hover over the object.

3. On the **Configuration** tab, select **Fundamental Tone** from the **Export signals (THD)** pull-down menu. The operation of the step changes from displaying the frequency-domain spectrum of the entire input signal to displaying only the frequency spectrum of the fundamental tone of the input signal. The signals in the top half of the **Step Setup** dialog box update to reflect the change you made.
4. Select **Harmonics Only** from the **Export signals (THD)** pull-down menu. The step changes to export only the spectrum of the harmonic signals from the input signal. Both the output signal of the Distortion step and the graph in the Data View update to reflect the change you made.
5. Click the **Amplitude and Levels** step in the Project View. The **Step Setup** dialog box changes from displaying the configuration of the Distortion step to displaying the configuration of the Amplitude and Levels step.
6. Click the **Input/Output** tab to display the list of possible inputs and outputs for this step, as shown in Figure 4-4.

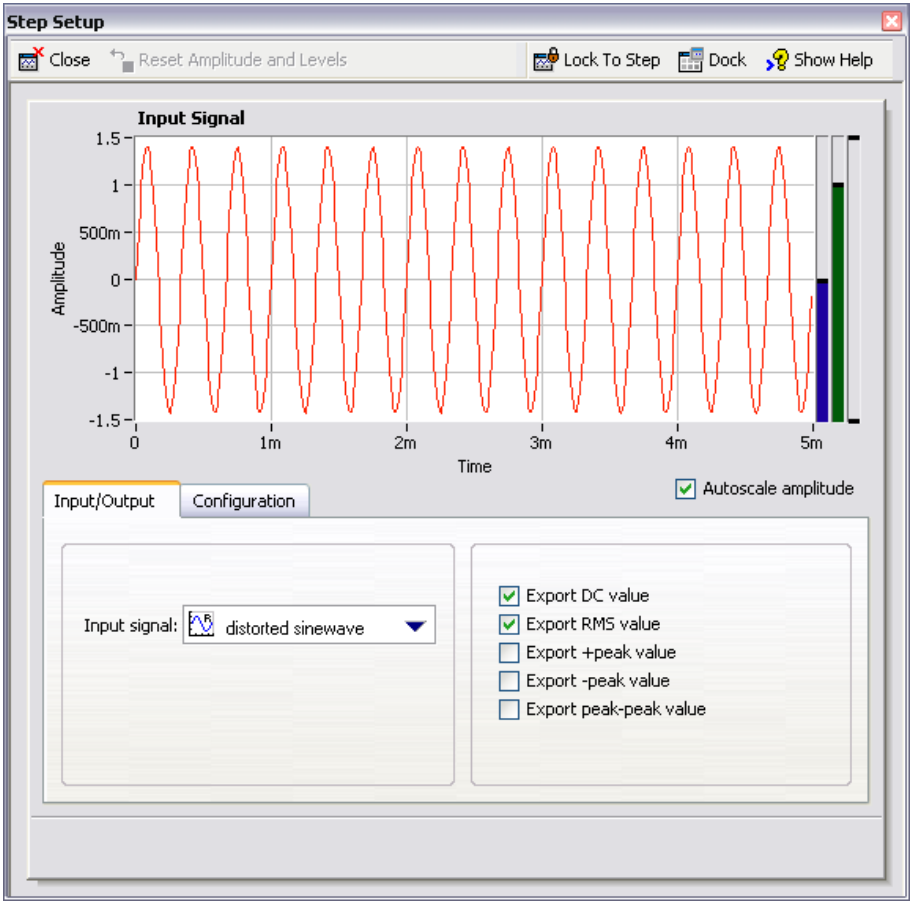


Figure 4-4. Amplitude and Levels Step Setup Dialog Box

7. Place checkmarks in the **Export +peak value**, **Export -peak value**, and **Export peak-peak value** checkboxes to configure the Amplitude and Levels step to return three additional measurements. Three additional outputs are now visible in the Project View.

8. Click the **Close** button, shown at left, in the **Step Setup** dialog box to close the Amplitude and Levels **Step Setup** dialog box.
9. Drag the three new outputs **+peak**, **-peak**, and **peak-peak** from the Project View to the Data View to display the scalar measurements.

10. Click the **Stop** button, shown at left, to stop the project.

    When you click the **Stop** button, the project stops running after completing the current cycle of operations, or the current iteration.

Clicking the **Abort** button completely stops the project without finishing the current iteration.

11. Select **File»Save Project As** and save the project as `My First Project.wbp` in the `<SignalExpressTekEd>\Examples\Tutorial` directory.
12. Select **File»Close Project** to close the project.

Moving and Deleting Steps

The steps in NI SignalExpress Tektronix Edition projects depend on input data, which means steps can operate only on signals exported from previous steps in the Project View. When you click the **Input signal** pull-down menu in the **Step Setup** dialog box of a step, the menu displays only compatible signals exported from a previous step. When the output of a step becomes the input of another step, the steps become dependent on each other, and the two steps execute sequentially at the same rate. The first step generates an output signal that the second step must receive as an input before the step can execute.

You can move a step within a project by dragging the step up or down in the Project View. You can delete a step by right-clicking the step in the Project View and selecting **Delete** from the shortcut menu. However, when you move or delete a step, the status of signals in the project changes. For example, if you delete a step that generates output signals, the operation of the project breaks if any of the deleted output signals are inputs for other steps, and an error indicator appears in the Project View. If you move a step lower in the project, the output signals of the step are not available as inputs to any of the previous steps.

You also can cut, copy, and paste steps within a project by pressing the <Ctrl-X>, <Ctrl-C>, and <Ctrl-V> keys, respectively, or by right-clicking a step in the Project View and selecting **Cut**, **Copy**, **Paste Before**, or **Paste After** from the shortcut menu.

Handling Errors and Warnings

If an error occurs while a project runs, an error indicator, shown at left, appears in the Project View on the step that encountered the error. Double-click the step with the error to display an error description across the bottom of the **Step Setup** dialog box. Click the **Details** button to the right of the error description to display the full error description.

NI SignalExpress Tektronix Edition logs all errors and warnings in the Event Log while a project runs. To display the Event Log, select **View»Event Log** and click the **Event Log** tab in the Data View area. Refer to the *NI Express Workbench Help* for more information about errors and warnings by selecting **Help»Express Workbench Help**, clicking the **Search** tab, and entering `errors`.

5

Working with Signals

You can use NI SignalExpress Tektronix Edition to generate and analyze signals to evaluate designs without programming. This chapter teaches you how to work with signals in NI SignalExpress Tektronix Edition, including how to plot signals on graphs, import signals from a file, interactively align and compare two signals, and save signals to a file.

Graphing Signals

Complete the following steps to plot signals in a sample project and examine the signals visually using cursors:

1. Select **File»Open Project**, navigate to the `<SignalExpressTekEd>\Examples\Tutorial` directory, and double-click `Signals.wbp`. This project configures the Create Signal step to create a square wave signal and the Filter step to perform a lowpass Butterworth filter.
2. Drag the **step signal** output of the Create Signal step to the Data View.
3. Drag the **filtered step** output of the Filter step to the Data View.

   You can plot signals of the same signal type on the same graph. Both the step signal and the filtered step signal are time-domain signals, so they appear on the same graph. If you want to plot signals of different types, drag the signals to the same graph and NI SignalExpress Tektronix Edition creates a new graph.

4. Click the **Add Display** button, shown at left, on the toolbar to create a new graph.
5. Drag the **filtered step** output of the Filter step to the new graph.
6. Right-click the new graph and select **Cursors** from the shortcut menu to display two interactive cursors, as shown in Figure 5-1.

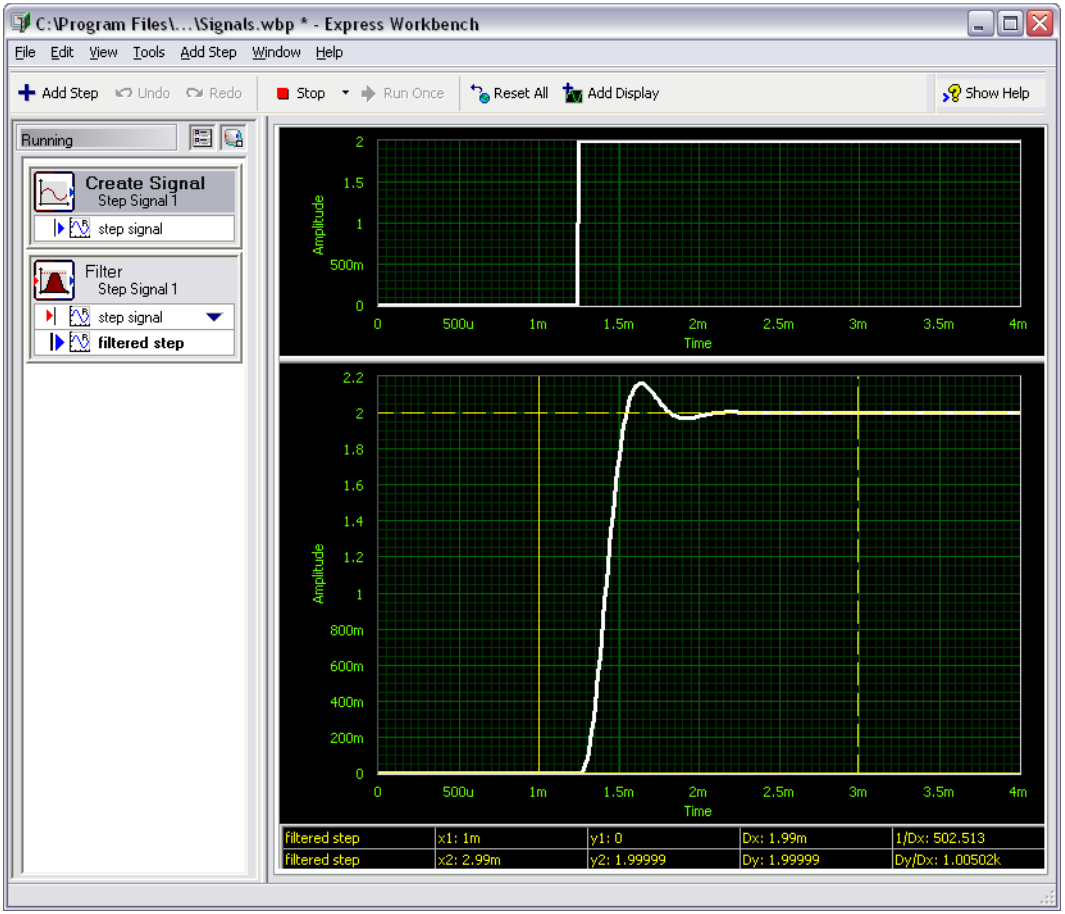


Figure 5-1. Signals.wbp

As you drag the cursors, NI SignalExpress Tektronix Edition displays the x and y values of the cursors in the cursor table at the bottom of the Data View.

7. Right-click the graphs to view other operations in the shortcut menu.

   If you have multiple signals on a single graph and one signal obscures another, you can change the order of the signals. If you run a project continuously but you want to view the data from a particular execution iteration, you can pause the display by right-clicking the Data View, selecting **Display Update** from the shortcut menu, and selecting **Always Update** to remove the checkmark next to it. You also can add or remove displays and add or remove signals.

8. Select **File»Save Project As** and save the project as `My Signals.wbp` in the `<SignalExpressTekEd>\Examples\Tutorial` directory.

Importing a Signal from a File

You can import signals from standard file formats such as ASCII, comma or tab-delimited files, and LabVIEW measurement data files (`.lvm`). You also can import signals from simulated results of EDA tools such as SPICE simulators.

Complete the following steps to import a signal from a file:

1. Right-click the Project View and select **Analog»Load/Save Signals» Load from ASCII** from the shortcut menu.
2. Click the **Browse** button, shown at left, in the **Step Setup** dialog box, navigate to the `<Program Files>\National Instruments\SignalExpressTekEd\Examples\Tutorial` directory, and double-click `Step Response.txt`. This step parses an ASCII file and displays the signals in the file.

   In the **File preview** section, Column 1 shows the time stamp data, and Column 2 shows the actual voltage values of the signal.
3. Click the **Import Signals** tab to display the available signals in the file.
4. Place a checkmark in the **Column 2** checkbox to import the signal, and remove the checkmark from the **Column 1** checkbox. The **Step Setup** dialog box displays a preview of the signal in the **Imported Signal** section.
5. Select **Column 1** from the **Input X values** pull-down menu to set the x-axis data of the waveform to the appropriate values.
6. Click the **Close** button to close the **Step Setup** dialog box.
7. Right-click the **Column 2** output in the Project View and select **Rename** from the shortcut menu.
8. Enter `step response` and press the <Enter> key to rename the output.
9. Drag the **step response** output of the Load from ASCII step to the lower graph. A dialog box launches because the two signals come from different sources and run at different rates.
10. Click the **Yes** button to display both signals on the same graph. The filtered step signal resembles the rising edge of the step response output, as shown in Figure 5-2.

C:\Program Files\...\Signals.wbp * - Express Workbench
File Edit View Tools Add Step Window Help
Add Step Undo Redo Run Run Once Reset All Add Display Show Help
Idle
Create Signal
Step Signal 1
step signal
Filter
Step Signal 1
step signal
filtered step
Load from ASCII
step response
Amplitude
Time
filtered step x1: 1.04m y1: 0 Dx: 1.95m 1/Dx: 512.821
filtered step x2: 2.99m y2: 1.99999 Dy: 1.99999 Dy/Dx: 1.02564k

Figure 5-2. Signals of My Signals.wbp

11. Select **File»Save Project** to save the project.

Aligning and Comparing Signals

Although the filtered step signal and the step response output both show an overshoot in the rising edge, assessing the similarity between the two is difficult because the signals come from different sources and vary in amplitude and timing. However, you can use the Interactive Alignment step to align and compare two signals, so you can choose which type of information you want to export from the operation to use in the project.

Complete the following steps to align two signals in the `My Signals.wbp` project:

1. Right-click the **step response** output and select **Send To»Analog» Processing»Interactive Alignment** from the shortcut menu to pass the step response signal from the Load from ASCII step to the Interactive Alignment step.

   The step selects the two most recent signals from the project to use as inputs and displays the signals on the graph of the **Step Setup** dialog box, as shown in Figure 5-3.

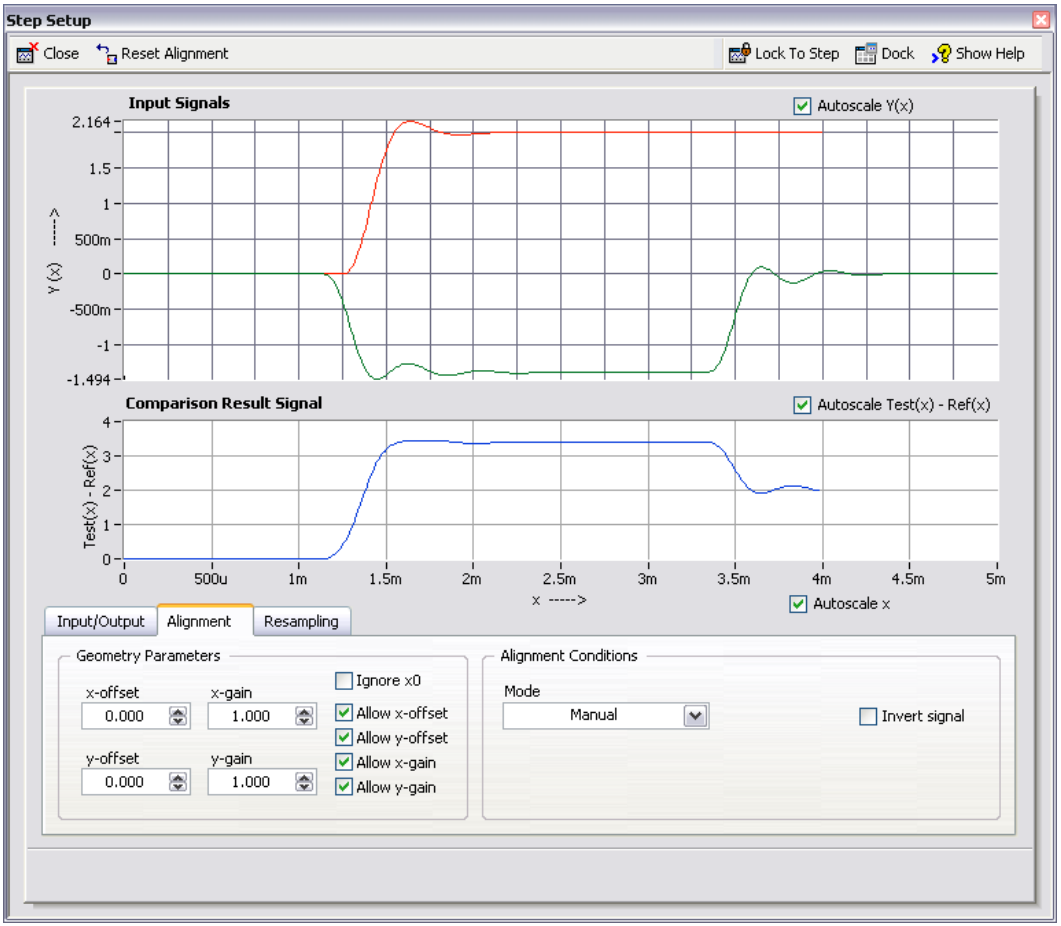


Figure 5-3. Interactive Alignment Step Setup Dialog Box

When you add a step to a project, NI SignalExpress Tektronix Edition selects input signals based on the signal types the step can accept.

For example, the Interactive Alignment step can operate only on time-domain waveform signals. Therefore, the step selects the last two time-domain signals created in the project as inputs. To change the input signals for a step, select different signals from the pull-down menu of compatible signals in the **Input/Output** tab of the **Step Setup** dialog box.

2. Click the red signal and drag it within the graph. You can drag, expand, and contract signals on the graph.
3. Try to align the rising edges of the two signals by dragging a signal within the graph. Click a signal to set an anchor point and press and hold the <Alt> key while you click and drag the signal around the anchor point. This stretches the signal in the x- and y- directions.

   On the **Alignment** tab of the **Step Setup** dialog box, the step computes and displays the x- and y-gain and x- and y-offset values you need to achieve alignment specifications as you drag the signals.
4. Select **Auto - Step** from the **Mode** pull-down menu to align the signals. NI SignalExpress Tektronix Edition bases this alignment mode on built-in algorithms.

   The lower graph in the **Step Setup** dialog box displays the difference between the two signals.
5. On the **Input/Output** tab, place a checkmark in the **Export aligned signals** checkbox to add the signals to the outputs of the step.
6. Click the **Close** button to close the **Step Setup** dialog box.

7. Click the **Add Display** button, shown at left, to add a third graph.
8. Drag the **aligned reference** and **aligned test** outputs of the Interactive Alignment step to the new graph to view the aligned signals.
9. Select **File»Save Project** to save the project.

Signal Types in NI SignalExpress Tektronix Edition

Some steps, such as the Arithmetic step, can operate on multiple signal types. For example, you can use the Arithmetic step to operate on time-domain or frequency-domain waveforms. The Arithmetic step changes behavior based on the type of input signals you select for the step. For example, if you add two time-domain signals, NI SignalExpress Tektronix Edition adds only their amplitudes. However, if you add two frequency-domain phase signals, NI SignalExpress Tektronix Edition adds the appropriate phase shift.

Refer to the *NI Express Workbench Help* for more information by selecting **Help»Express Workbench Help**, clicking the **Search** tab, and entering `"signal types"`.

Exporting and Printing Signals

NI SignalExpress Tektronix Edition offers several documentation features so you can continue analysis in another software application, such as Microsoft Excel or the report generation tool in NI DIAdem. These features can help you document the data from NI SignalExpress Tektronix Edition in reports.

Exporting Signals to Microsoft Excel

To export signal data to Microsoft Excel, launch Microsoft Excel and drag the output signal of a step in NI SignalExpress Tektronix Edition to a Microsoft Excel spreadsheet.

Printing Signals

To print an image of a graph, right-click the Data View and select **Export»Print Display** from the shortcut menu.

Saving Signals as Images

To save an image of a graph as a `.png` file, right-click the Data View and select **Export»Save as Image** from the shortcut menu. You can import a `.png` file into Microsoft Word or any other documentation tool.

Saving Tektronix Scope Images

To save an image from your scope to a `.png` file, left-click the down arrow on the **Utilities** menu in the **Step Setup** dialog box and select **Save Image**. You can import a `.png` file into Microsoft Word or any other documentation tool.

Logging Data to a File

You can print graphs of signals and export or save signal data to view it in spreadsheet applications.

Complete the following steps to save a signal to a file:

1. Click the **Add Step** button and select **Analog»Load/Save Signals» Save to ASCII/LVM**.

2. Click the **Signals** tab in the **Step Setup** dialog box and select a signal from the **Input Data** pull-down menu.
3. On the **File Settings** tab complete the following:
   a. Select **Overwrite** from the **If file already exists** pull-down menu.
   b. Select **Generic ASCII (.txt)** from the **Export file type** pull-down menu. You can use a Load/Save Signals step to save data to a file every time the project runs.
   c. Save the file to `<SignalExpressTekEd>\Examples\Tutorial\filtered signal.txt`.
4. Click the **Close** button to close the **Step Setup** dialog box.
5. Select **File»Save Project** to save the project.
6. Select **File»Close Project** to close the project.

6

Performing Sweep Measurements

You can use NI SignalExpress Tektronix Edition to automate measurements to characterize and validate designs by creating sweep operations. You can use the sweep measurements to gather data from designs over a range of conditions to document the performance of the designs. For example, you can use sweep operations to vary the frequency of a stimulus signal or vary the level of a supply voltage while taking measurements to characterize designs.

This chapter teaches you how to set up sweep operations using the Sweep step in NI SignalExpress Tektronix Edition. You learn how to characterize the performance of a filter by sweeping through a range of frequency values and measuring the output of the filter. You also learn how to display sweep results and perform multi-dimensional sweeps for more complex measurements.

Defining Sweep Ranges and Outputs

You can use the Sweep step in NI SignalExpress Tektronix Edition to define automated measurements for complex, repeatable sweep operations.

Complete the following steps to define a frequency range in a sample project to sweep through a filter:

1. Select **File»Open Project**, navigate to the `<SignalExpressTekEd>\Examples\Tutorial` directory, and double-click `Sweep.wbp`.

2. Click the **Run** button, shown at left, to run the project.

   The project generates a sine wave stimulus signal using the Create Signal step, passes it through a bandpass elliptic filter using the Filter step, measures the RMS level of the filter output using the Amplitude and Levels step, and converts the level to decibels (dB) using the Formula step. The Filter step acts as a simulated unit under test (UUT), so the project does not use instrumentation. However, you also can sweep physical signals that a Tektronix signal generator generates.

3. Click the **Add Step** button, shown at left, and select **Operations»Sweep**.
4. Click the **Add** button in the **Step Setup** dialog box to display the list of sweep parameters from each step in the project, as shown in Figure 6-1.

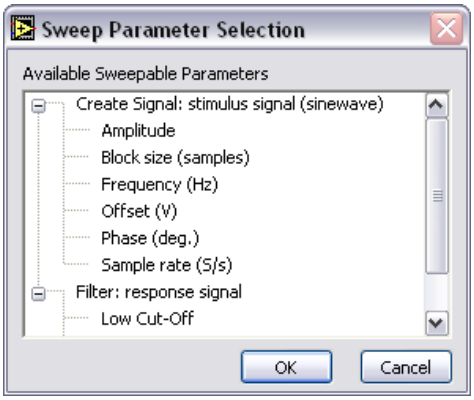


Figure 6-1. Sweep Parameter Selection Dialog Box

5. Select the **Frequency (Hz)** parameter under **Create Signal: stimulus signal (sinewave)** and click the **OK** button.
6. On the **Sweep Configuration** tab, select **Exponential** from the **Type** pull-down menu.
7. Enter `1k` in the **Start Frequency (Hz)** spin control, and enter `40k` in the **Stop Frequency (Hz)** spin control.
8. Enter `150` in the **Number of points** spin control.

   The **Sweep Configuration** tab should appear as shown in Figure 6-2.

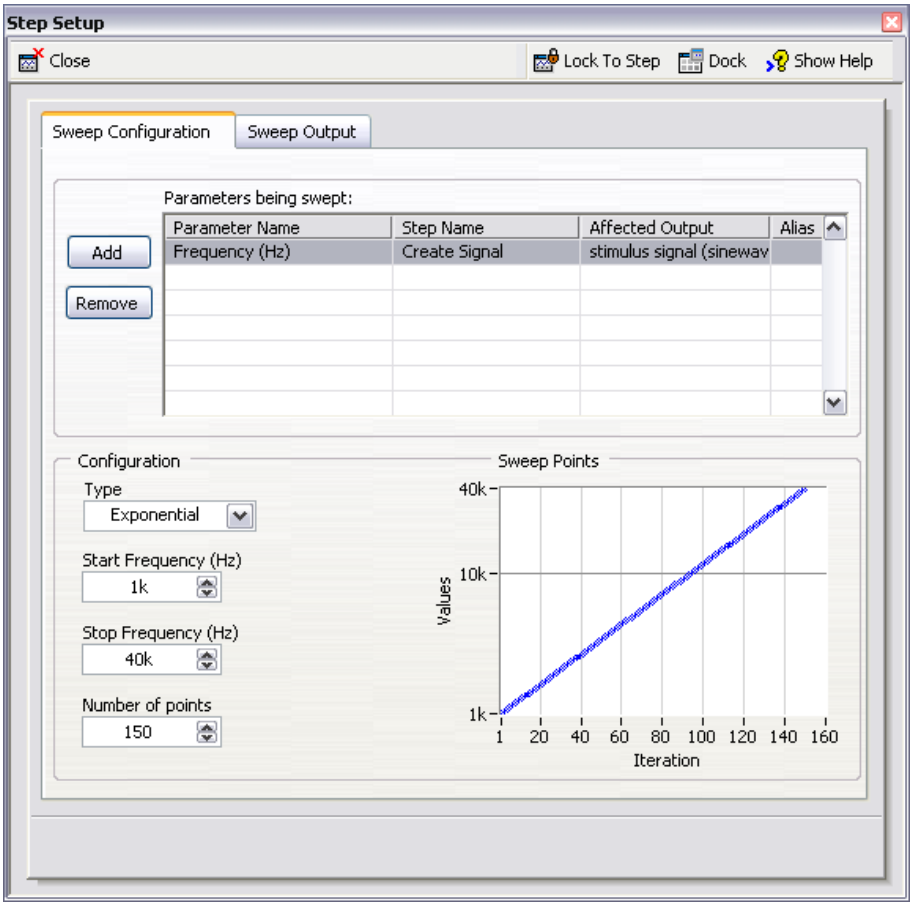


Figure 6-2. Sweep Step Setup Dialog Box

You use the Sweep step to specify a range of values to iterate through the Frequency (Hz) parameter of the Create Signal step. The Create Signal step uses the defined frequency range to generate a sine wave at each of these frequencies. However, you can use the Sweep step to sweep any sweepable parameter value of any sweepable step in a project.

9. Click the **Sweep Output** tab.
10. Click the **Add** button to display the list of sweep outputs from each step in the project.
11. Select the **response amplitude in dB** output under **Formula (Scalar)** and click the **OK** button to plot this measurement against the swept Frequency (Hz) parameter.

12. Click the **Close** button, shown at left, to close the **Step Setup** dialog box.

The Sweep step creates a loop around all the steps in the project to include all the steps in the sweep operation.

Plotting Sweep Results

Complete the following steps to run the sweep measurement:

1. Click the **Run Once** button, shown at left, to execute the sweep measurement.

   The stimulus signal output on the graph iterates through the specified range of frequencies.

2. Drag the **response amplitude in dB vs. Frequency (Hz)** signal from the bottom of the Sweep loop to the Data View to display the output of the sweep.

   NI SignalExpress Tektronix Edition creates a new graph. The data from a sweep operation is an x-y array that requires a separate graph, as shown in Figure 6-3.

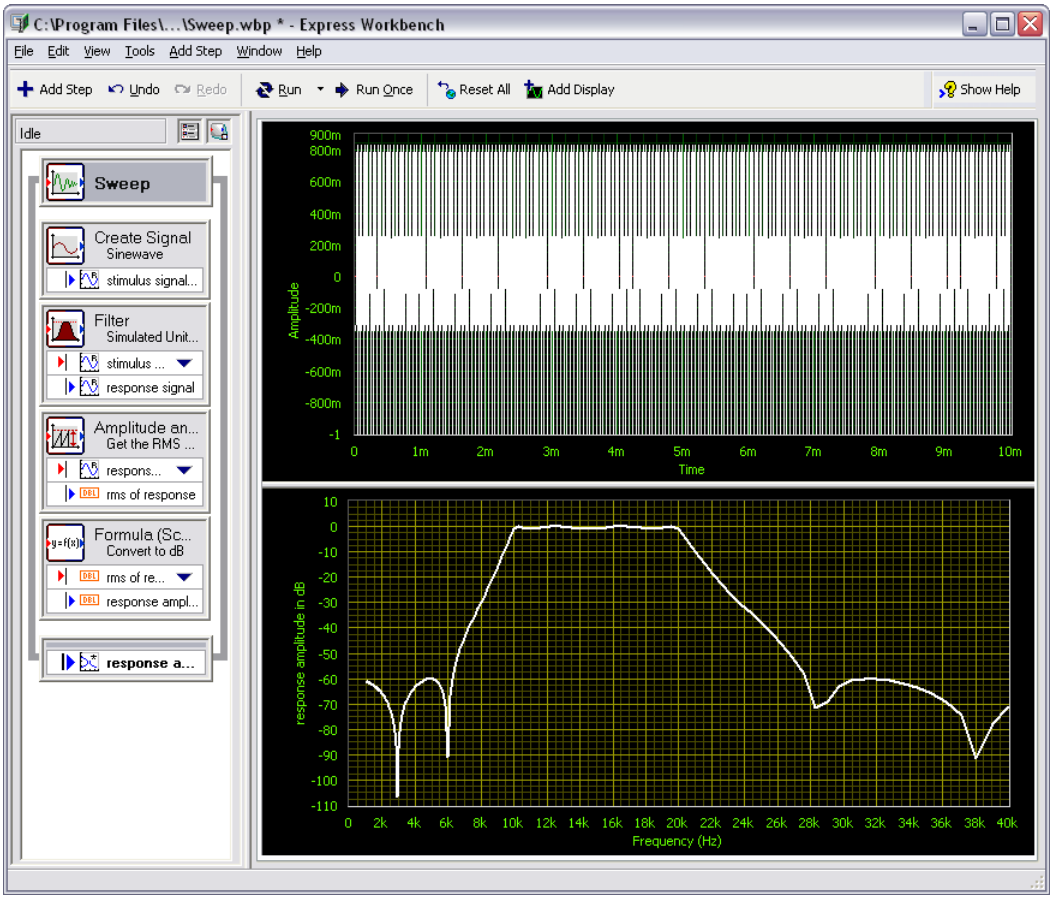


Figure 6-3. Graph Output from Sweep Operation

3. Click the **Run Once** button again to execute the sweep. The frequency response of the Filter step plots on the new graph while the project runs. The graph displays the transfer function of the filter, or the amplitude output expressed in decibels versus the frequency.
4. Double-click the **Filter** step to display the filter specifications in the **Step Setup** dialog box. The frequency response of the filter in the Filter Magnitude Response (dB) graph matches the graph in the Data View.
5. Click the **Close** button to close the **Step Setup** dialog box.
6. Select **File»Save Project As** and save the project as `My Sweep.wbp` in the `<SignalExpressTekEd>\Examples\Tutorial` directory.

You can use the Sweep step to sweep multiple parameters simultaneously by adding additional parameters on the **Configuration** tab of the Sweep **Step Setup** dialog box. Sweeping two or more parameters in unison is a parallel sweep. For example, if you want to vary the amplitude of a stimulus signal, you can run a parallel sweep. You can use a parallel sweep to maximize the precision of the acquisition by varying the vertical scale of a Tektronix oscilloscope as you vary the signal level. As the signal level increases, you can increase the input range of the measurement device to ensure you use the entire resolution for the measurement.

Running Multi-Dimensional Sweeps

Use multi-dimensional, or nested, sweeps to iterate through one range while you vary another range. For example, if you want to sweep through frequencies of a stimulus signal at different amplitudes, run a nested sweep.

You can set the amplitude to level 1 and sweep through frequencies, then set the amplitude to level 2 and sweep through frequencies, and so on. You can build a nested sweep by right-clicking a **Sweep** step in a project and selecting **Add Dimension** from the shortcut menu to add another sweep loop.

Complete the following steps to run a sample nested sweep project:

1. Select **File»Open**, navigate to the `<SignalExpressTekEd>\Examples\Tutorial` directory, and double-click `Nested Sweep.wbp`.

2. Click the **Run** button, shown at left, to run the project.

   Each iteration of the inner sweep loop sweeps the frequency of the stimulus signal. The outer sweep loop varies the low and high cutoff frequencies of the Filter step. Each iteration appears in real time on the upper graph, then appears on the lower graph to display all the sweeps at each cutoff frequency setting, as shown in Figure 6-4.

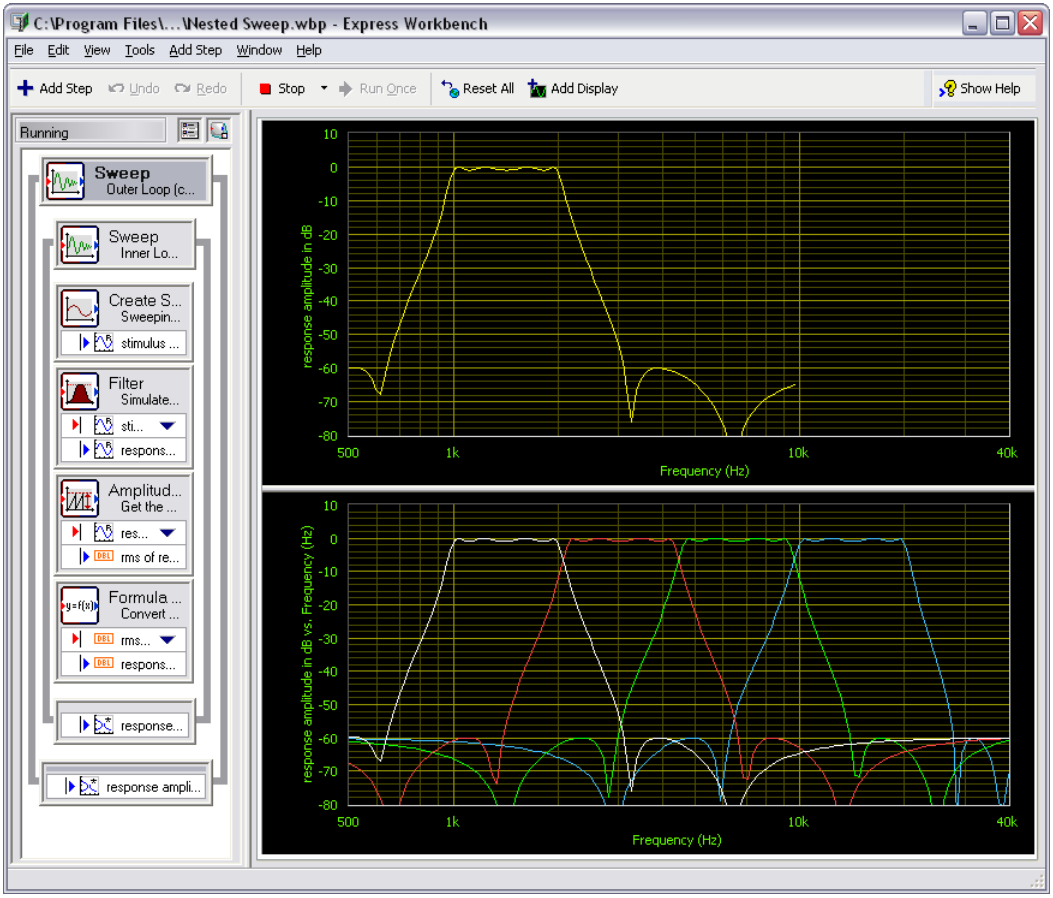


Figure 6-4. Nested Sweep.wpb

3. Click the **Stop** button, shown at left, to stop the project.

7

Extending NI SignalExpress Tektronix Edition Projects with LabVIEW

You can use NI SignalExpress Tektronix Edition to define automated measurements without programming applications by using built-in steps for acquiring, generating, or analyzing signals. You can extend the functionality of NI SignalExpress Tektronix Edition by building a user-defined step, or VI, in LabVIEW and importing the VI into NI SignalExpress Tektronix Edition to expand the number of steps available in NI SignalExpress Tektronix Edition.

Note You must have LabVIEW 7.1 or later to complete the exercises in this chapter.

Importing LabVIEW VIs into NI SignalExpress Tektronix Edition as Steps

You can use the User-Defined step in NI SignalExpress Tektronix Edition to call custom LabVIEW VIs. You also can call a LabVIEW VI from NI SignalExpress Tektronix Edition to do the following:

- Control standalone instruments
- Read or write data to more file formats
- Display operator instructions in a pop-up dialog box
- Define a measurement algorithm

Complete the following steps to import a VI from LabVIEW with the User-Defined step:

1. Select **File»Open Project**, navigate to the `<SignalExpressTekEd>\Examples\Tutorial` directory, and double-click `User Step.wbp`. This project uses the Create Signal step to generate a signal.
2. Click the **Add Step** button and select **User-Defined Step**.

3. Click the **Browse** button on the **Step Setup** dialog box and select `Limiter.vi` in the `<SignalExpressTekEd>\Examples\Tutorial` directory. The Limiter VI accepts a time-domain waveform as an input, clips the signal above and below values that you specify in the **Step Setup** dialog box, and returns the clipped waveform as an output signal.

   When you import a LabVIEW VI, NI SignalExpress Tektronix Edition maps the inputs of the VI as parameters and the outputs of the VI as output signals.

   You can define an input as an input signal to make it available in the Project View as an input to a step, which means you can pass signals as inputs to a VI. In this project, the VI contains the input signal **Time waveform in**.

4. Select **Clipped waveform out** in the **Outputs** list and select **Time Waveform, Real** from the **Strict Type of Output Data** pull-down menu to specify **Clipped waveform out** as a time-domain waveform. The **Step Setup** dialog box should appear as shown in Figure 7-1.

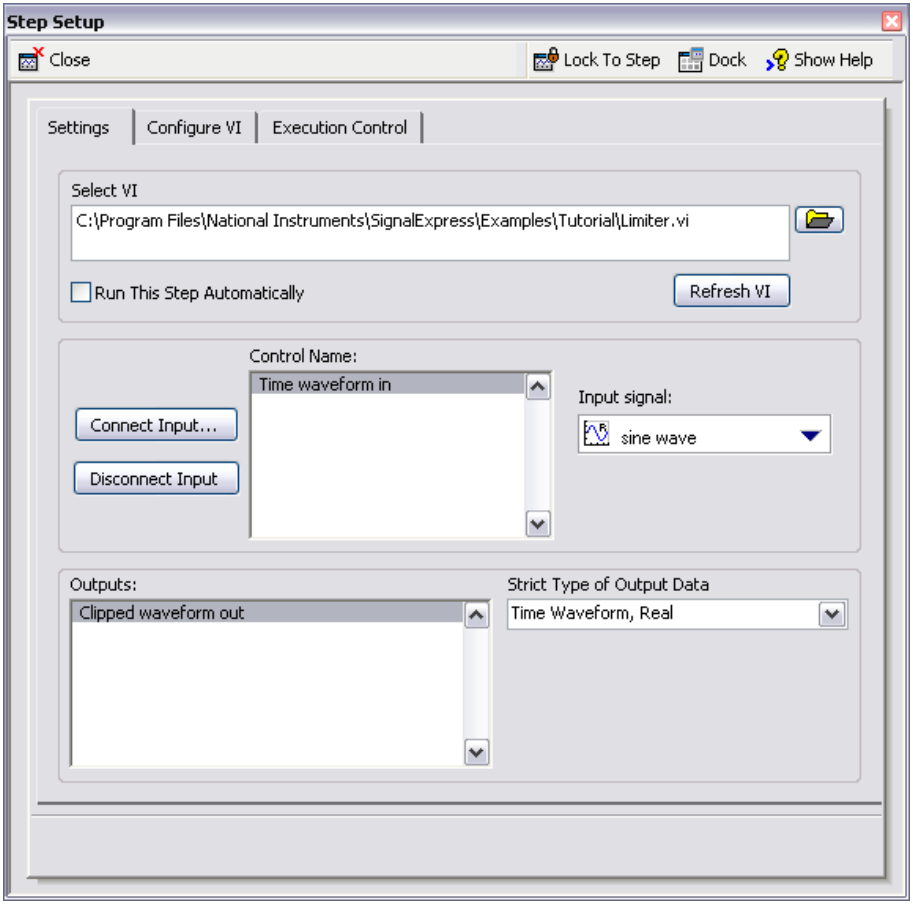


Figure 7-1. Limiter VI Step Setup Dialog Box

5. Click the **Close** button, shown at left, to close the **Step Setup** dialog box.
6. Click the **Run** button, shown at left, to run the project.
7. Drag the **Clipped waveform out** output signal from the **Limiter.vi** step to the Data View.
8. Double-click the **Limiter.vi** step to display the **Step Setup** dialog box.
9. Click the **Configure VI** tab to display the front panel of the VI.
10. Enter new values in the **Upper limit** and **Lower limit** fields. For example, enter `100` in the **Upper limit** spin control as shown in Figure 7-2.

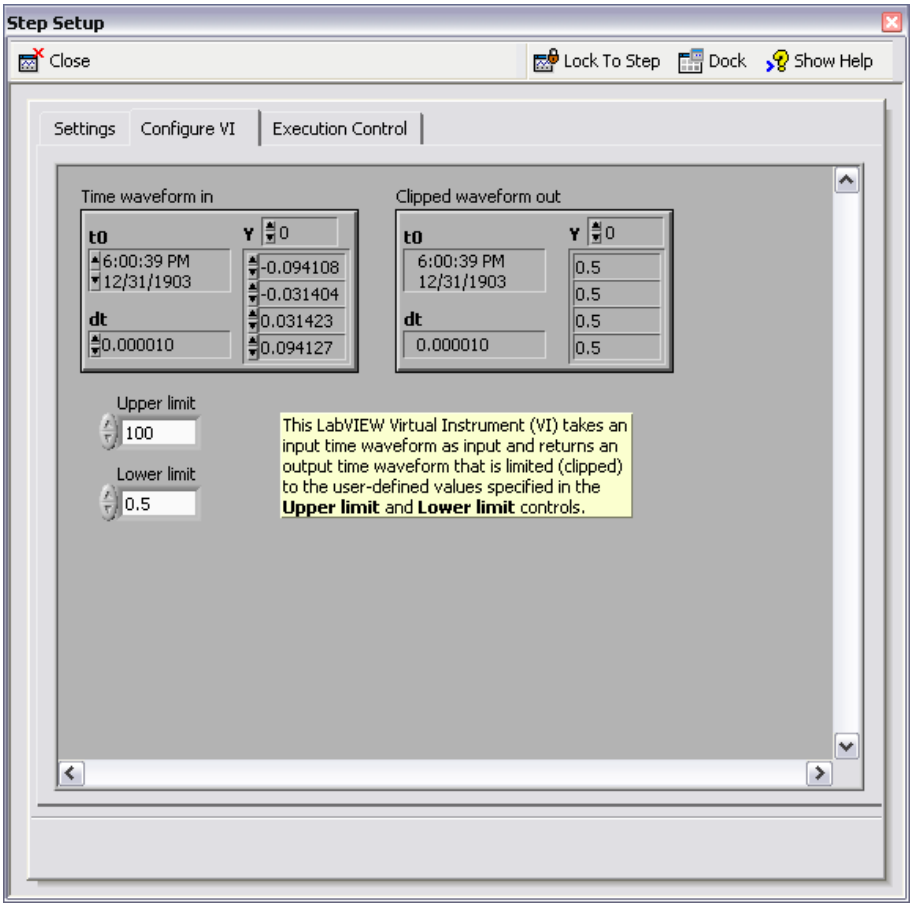


Figure 7-2. Configure VI Tab

11. Click the **Close** button to close the **Step Setup** dialog box. The **Clipped waveform out** output signal changes on the Data View to reflect the changes you made.

Refer to the *NI Express Workbench Help* for more information about using LabVIEW VIs in NI SignalExpress Tektronix Edition and how to develop VIs that work well in NI SignalExpress Tektronix Edition.

8

Where to Go from Here

Refer to the following resources for more information about NI SignalExpress Tektronix Edition.

NI SignalExpress Tektronix Edition Sample Projects

NI SignalExpress Tektronix Edition provides a variety of sample projects that demonstrate more capabilities of NI SignalExpress Tektronix Edition. These projects are located in the `<SignalExpressTekEd>\Examples` directory. Review these examples to learn more about the features of NI SignalExpress Tektronix Edition or to start with a project that closely resembles your needs.

Using Other Instruments with NI SignalExpress Tektronix Edition

Along with the Tektronix DPO4000, TDS3000, and AFG3000 series instruments, NI SignalExpress Tektronix Edition supports over 400 of the most common standalone and plug-in instruments. Refer to the *NI Express Workbench Help* for more information about using other instruments with NI SignalExpress Tektronix Edition by selecting **Help»Express Workbench Help**.

Related Documentation

Refer to the *Getting Started with SignalExpress* manual to familiarize yourself with the basic features that you use to acquire and analyze signals. This manual contains exercises that help you begin working with SignalExpress.

The *Getting Started with SignalExpress* manual is a Portable Document Format (PDF). You must have Adobe Reader with Search and Accessibility 5.0.5 or later installed to view the PDF. Refer to the Adobe Systems Incorporated Web site to download Adobe Reader. Refer

to the National Instruments Product Manuals Library at `ni.com/manuals` for updated documentation resources.

Web Resources

Refer to the National Instruments Web site at `ni.com/tek` for resources such as example projects, technical documents, and LabVIEW VIs written for use in NI SignalExpress Tektronix Edition.

A

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
  - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
  - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Developer Exchange at ni.com/exchange. National Instruments Application Engineers make sure every question receives an answer.

    For information about other technical support options in your area, visit ni.com/services or contact your local office at ni.com/contact.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.